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To the Committee on Graduate Study:

I am submitting to you a thesis written by Richard G. Garner entitled "The Processing of Unfermented Peach Juice." I recommend that it be accepted for twelve quarter hours credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Horticulture.

Arthur Meyer
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We have read this thesis
and recommend its acceptance:

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THE PROCESSING OF UNFERMENTED PEACH JUICE

A THESIS

Submitted to
The Committee on Graduate Study
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

by

Richard G. Garner

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R. G. G.

INTRODUCTION

The great increase in the consumption of fruit juices in recent years has stimulated interest in their production. Present trends have further emphasized this growing tendency of the consuming public to "drink their fruit". Therefore, the phenomenal increase in production and utilization of fruit juices as a means of providing a market for cull, surplus, or even fruit of better quality has become exceedingly important. Some idea of just how important the juice production industry has become may be gained from studying the data on the production of canned juices in Table I.

The expansion of the market for fruit juices has been an outgrowth of an effective advertising campaign which popularized the drinking of fruit juices at breakfast. Advances in technology of production resulting in higher quality and the development of suitable containers have also been responsible for the present favorable acceptance of fruit juices by the public. Consequently, new products are now more favorably received by the trade than at any previous time.

A recent survey reported in Barron's National Business and Financial Weekly (1948) has shown that the trend is toward increased production in the soft-drink industry. According to this report, an estimated volume of sales amounting to 850 million cases is expected, which would entail an estimated expenditure of approximately \$7 per capita in 1948. In view of this data, it would appear that the

TABLE I

TOTAL PRODUCTION OF FRUIT AND VEGETABLE JUICES:

1935-36 to 1946-47^a

Year	Millions of Standard Cases (24 No. 2 Cans)
1935-36	24.0
1936-37	36.7
1937-38	40.8
1938-39	40.8
1939-40	46.6
1940-41	57.7
1941-42	63.0
1942-43	76.0
1943-44	80.7
1944-45	96.7
1945-46	108.8
1946-47	114.6

^aSource: United States Department of Commerce. Bureau of Census. Statistical abstracts, 1947, p. 676.

beverage drinking habits of the American public are very pronounced. However, it is believed that fruit juices, high in quality and nutritional value, would be more desirable for satisfying this demand.

The most important consideration in the preparation and preservation of fruit juices has long been known to be that of maintaining quality. Regardless of the method of preservation used, it has not been possible to improve upon the original quality of the juice. Hence, the main object in fruit juice production has continued to be the retention of as much as possible of the fresh fruit characteristics in the finished product. To accomplish this end, the appearance, delicate fresh flavor and odor, color and nutritional value must not be destroyed during processing.

If the product reaches the consuming public with a minimum of undesirable qualities, several important factors must be carefully controlled. Of these factors the following are considered the most significant: the selection and preparation of the fruit, the extraction of the juice, the control of the appearance and stability of the juice, clarification and preservation.

Due to the fact that peaches have enjoyed such a widespread popularity as fresh fruit, it is believed that a fruit juice manufactured from them would be very much in demand. Opinions of the leading investigators have been at variance concerning the adaptability of the peach for such purpose.

OBJECTIVE

Investigators are generally convinced that the utilization of peaches in the production of juice would be desirable. However, many investigators differ concerning the best type of juice to prepare and the varieties most desirable for its production. Some feel that the mere application of the basic principles involved in preparation and preservation of fruit juices now on the market will not produce a satisfactory product; others feel that the peach is too deficient in flavor and odor for juice production. Experiments which have furnished the data for this report were initiated in an attempt to find more conclusive evidence to answer these questions.

LITERATURE REVIEW

The recent improvements and advances in the technological methods of preparation and preservation of foods coupled with the accumulation of surplus supplies, due to the application of scientific production measures, has stimulated research into possible ways of better utilization of agricultural products. Fruit products manufacturers are among those searching for new or improved methods of preparing or preserving their products. If a process only makes it possible to store products better than is possible at the present, it will justify itself economically. However, a better process would be one that would yield the consumer more accessible food value and at the same time increase the ultimate demand upon the grower and packer.

Unfermented apple cider and grape juice have been popular beverages for centuries. However, methods of preservation, to make these fruits available during other than the fresh season, were not seriously considered until Gore (1908) studied and proposed methods for the preparation and canning of apple juice. He suggested preparing a clarified, carbonated beverage from the juice. Later, Gore (1910) suggested the freezing preservation of apple juice.

Expansion in the juice industry continued slowly and Gore (1915) again initiated study with peaches by pasteurizing and filtering peach juice and reported that the product was not particularly attractive and consequently did not possess commercial possibilities. Cruess, Overholser, and Bjarnason (1920), in an effort to discover methods of

preservation for grape juice, reported that grape juice retained its fresh flavor and color practically unchanged in sealed containers at 0°F. Caldwell (1922) made extensive studies on the clarification of unfermented fruit juices and reported that flavor is probably determined in part by the colloidal material in the juice.

Cruess and Irish (1923) were the first to experiment with the canning of various pulpy peach beverages and recognize their possibilities. However, they also gave details on the preparation, preservation and use of fruit juices and beverages prepared by clarification and carbonation and recommended the freezing storage of unsweetened fruit juices as superior to all other known methods of preservation of such products for use at soda fountains. Next Cruess (1926) studied canning plum juice and proposed methods of making plum beverages. Then, de Pasquale (1929), in Australia, experimented with the making of both clear and pulpy apricot, peach and pear beverages and suggested that these beverages might possess commercial possibilities.

Joslyn (1930) learned that fresh juices properly preserved and frozen retained their fresh flavor and odor without noticeable change and gave directions for the preservation of fruit juices and fruit syrups by freezing. Peach juice, peach syrup, and peach juice beverages were experimented with by Irish (1932) and procedures for the preparation of the juice reported. Working on problems of sterilization, Cruess, Aref, and Irish (1933) found that juice from very ripe fruit low in acid was more difficult to sterilize than that from more acid, less ripe fruit. Great possibilities for pulpy apricot beverages were indicated by Shallah

and Cruess (1934).

The rapid development of freezing storage as a method of preservation stimulated experiments as Joslyn and Marsh (1934) found orange juice retained its fresh flavor and aroma better in freezing storage if it were deaerated immediately after burring and were flash pasteurized and cooled rapidly. Addition of 50 p.p.m. of SO₂ to untreated orange juice aided greatly in flavor retention in the frozen juice during storage. Shuey (1934) found that the color might be fixed in preparing strawberry juice by heating the berries for 15 minutes at 190⁰F. before pressing. He also recommended the addition of 12 percent sugar to the juice as well as developed a method for utilizing sweet potatoes in the production of sweet potato sirup. Cruess (1936) suggested use of free-stone highly flavored peaches to make a beverage containing equal parts of juice and sirup. Pederson and Tressler (1936) also discovered that if Concord grapes were to be sterilized by filtration, they must be heated sufficiently to inactivate the enzymes, otherwise undesirable changes of flavor occur.

The tempo of experimentation was further accelerated by Joslyn and Marsh (1937) showing the utilization of fruit in commercial production of fruit juices to have many unexhausted possibilities and recommending a process for the preparation of a pulpy peach beverage which is now in demand. Prescott and Proctor (1937) showed the possession of a sharp, tart flavor and aroma to be a good guide in selecting fruits for making juice. Mrak (1937) discovered the diffusion method of

preparation of prune juice and pointed out the advantages it offered to canners.

Celmer and Cruess (1937) contributed by learning that apple juice could be satisfactorily preserved by pasteurization in berry enamel cans. They also found that a temperature of 140-150° F. for ten minutes or merely flash pasteurization at 185°F. is sufficient to preserve canned juice. They further recommended canning apple juice as an excellent means of utilizing surplus apples. Bilham (1937) found and gave a detailed explanation of how fruit juices may be concentrated by freezing. Ockey (1938) further called attention to the utilization of surplus unsalable fruit and vegetables for the production of juice.

Tressler, Joslyn, and Marsh (1939) reported that the present trend favors cloudy and pulpy juices in preference to clarified juices, one of the reasons being that, as a rule, cloudy juices have more flavor than highly clarified juices. Commercially important apricot, peach, and pear "nectar" and beverages were almost invariably shown to be pulpy. They further discovered that if Elberta or some other of the better quality and well-flavored freestones were used, a very desirable beverage may be produced. It was also found that, if care is taken to eliminate air in the head space of the bottled product, flash pasteurization temperatures as low as 165°F. may be used.

Tucker (1941) studied the formation of ice crystals and developed a practical method for concentrating fruit juices by freezing and centrifuging. Beavens and Beattie (1942) developed methods for the preparation

of juice, of the pulpy type, from peach, pear, and plum. They also found blending of juices and the addition of sugar sirup to be desirable in the case of peaches. Tressler, Peterson, and Beattie (1942) tried fruit and vegetable juice preparation and preservation and learned that addition of citric or lactic acid or acidification of a non-acid with an acid juice permits flash pasteurization.

Vegetable juices were recommended as good products by Marsh (1942). At the same time, Cruess (1942), experimented with and prepared fruit concentrates successfully by use of a continuous vacuum concentrator and by freezing. Consequently, the number and importance of fruit juices caused Tanner (1944) to study the microbial problems of fruit juices.

Next Cruess (1944) pointed out additional uses for fruit syrups and concentrates. Processing for peaches and peach juices in the future was believed to include sieving, crushing and blending by Cruess (1945). Cruess and Grazewski (1945) found frozen apple juice to have commercial possibilities. Experimental evidence to prove the practicality of freezing fruit juices was presented by Cruess, Hohl, and Grazewski (1945). Carlton (1945) also reported that fruit juices might be frozen with or without sugar. Good quality juices and purees from strawberries and blackberries were prepared and preserved by freezing by Shuey (1945).

Development continued at a rapid rate and Cruess (1946) used fruit juices and purees in preparing jellied fruit candies; Cruess, Friar, and Shearing (1946) also developed a granular product from

orange juice for use in candy, as an addition to dry breakfast cereals, in milk shakes and in fruit punches. Pectinal enzymes were successfully tried in preparing prune juice by Creuss, Leonard, Ponting and Lane (1946), while Curl (1946) showed how experimental work had been successful in the preparation of tangerine juice. Cruess and Grazewski (1946) stated that vegetable juices possessed possibilities.

In more recent developments, Paul (1947) demonstrated a successful method for concentration of fruit juice from fruits by freezing and pointed out that the process had possibilities in the production of fruit concentrates for commercial use. Kertesz (1947) found the Germans using more advanced methods, including mellowing by mold enzymes, concentration by continuous freezing, and storage in CO₂ under pressure in handling juice. Tressler and Evers (1947) summarized the successful methods in the manufacture and freezing of fruit juices and suggested freezing as a method of preserving fruit juices and making fruit concentrates. Cruess and Seagrave-Smith (1947) successfully froze citrus juice. The possibility of preparing fresh lemonade from frozen concentrates was pointed out by Cruess, Seagrave-Smith and Grazewski (1947).

Some investigators experienced difficulty in extracting the juice from the peach. Bentley (1947) reported that the seemingly elementary operation of squeezing the juice from the pulp posed an engineering problem of considerable proportions, the solution of which was not yet satisfactorily completed. He also stated that examination of peaches under the microscope revealed that the juice is encased in tiny segments, prolately spheroidal in nature, with a skin of pectinous material. He

further pointed out that these pectinous and gelatinous particles made extraction of peach juice difficult even though the juice comprised from 85 to 88 percent of the peach by weight. Chatfield and Adams (1940) reported that the average moisture content of the peach was 86.9 percent.

Griffin, Talley and Heller (1945) announced a process for recovering in concentrated form the volatile, fragrant constituents, called essence, of apple juice and returning it to the finished product. They observed that an apple juice which had lost its essence did not possess a typical apple flavor but that an apple juice to which this essence had been returned did have a typical apple flavor. Likewise, Davis (1948) described methods of preparing apple and peach essence and called attention to their use.

Marshall (1948) outlined methods for the preparation of high quality apple juice and emphasized the importance of quality. Lee and Pederson (1948) conducted studies with frozen apple juice and found that extracting the juice at low temperature yielded a higher quality juice. They also found that fortifying with 20 milligrams of ascorbic acid per 3 1/3 fluid ounces improved the color and flavor. Cruess (1948) reported peach nectar could be prepared by pitting, peeling, steaming until soft, sieving, mixing with dilute sirup and canning. Cruess (1948) also reported that fruit-cola beverages prepared by mixing fruit and cola concentrates possessed commercial possibilities. He stated that prune-cola was especially good.

EXPERIMENTAL PROCEDURE AND METHODS

The varieties of peaches employed in this study were Golden Jubilee, Carman, Early Elberta and Elberta. These varieties, which have good possibilities in this area, were selected to include both yellow-flesh and white-flesh types. They were secured from the orchard of the Horticultural Department of the University of Tennessee at Knoxville.

The data contained in this thesis were collected from experiments conducted utilizing the facilities of the food processing laboratories of the Horticulture and General Chemistry Departments of the College of Agriculture.

The peaches were picked at the stage of maturity deemed most favorable for making juice. The fruit was permitted to ripen on the tree until suitable for eating out of hand, picked and converted into juice as rapidly as possible, usually the same day as picked. Methods of harvesting and sorting were standardized at the outset in order to secure uniformity in treatment of materials to be subsequently compared.

Methods of preparation of the fruit were varied in an attempt to find the method giving the greatest yield of highest quality juice. Exploratory experiments were conducted using peeled and unpeeled fruit, pitted and unpitted fruit, as well as whole fruit and pulped fruit in an attempt to ascertain their separate or collective influence on yield, flavor, aroma and appearance of the fruit.

In the extraction of the juice various methods were also tried. Some portions of the fruit were peeled, pitted, heated to 165°F., pulped by passing through a tomato juice extractor and then subjected to pressure

extraction tests using either a cider press or the pilot extractor in the General Chemistry laboratory of the College of Agriculture. Other portions were subjected to pressure extraction tests without being pulped or heated. The extraction tests were designed to produce a clear juice and to secure, as closely as possible, yields approaching the actual moisture content of the fruit.

Simultaneous with the extraction tests, studies were conducted on the manufacture of a pulpy peach beverage. The peaches were washed, peeled, pitted, heated to 165°F. and pulped by passing through a tomato juice extractor. The resulting puree was diluted with an equal volume of cane-sugar sirup of 15° Balling, filled into glass quart jars, exhausted to 180°F., sealed, processed for twenty minutes at 212°F. and very thoroughly cooled.

Another problem encountered was the control of the appearance and stability of the juice. Browning of peaches, a problem familiar to those canning or freezing peaches, was also confronted in juice production. Browning control experiments prior to and after extraction of the juice or pulping of the fruit were conducted using citric acid, sodium bisulphite and ascorbic acid as antioxidants. Various clarification or filtration methods were tried in supplementary studies. Carrageen extract was used in an attempt to stabilize the pulpy juice which tended to layer and settle in a very peculiar manner.

In the preservation studies, the juice was canned and frozen. Glass containers were used in all preservation studies in order that observations might be made during the storage period. The canned juice

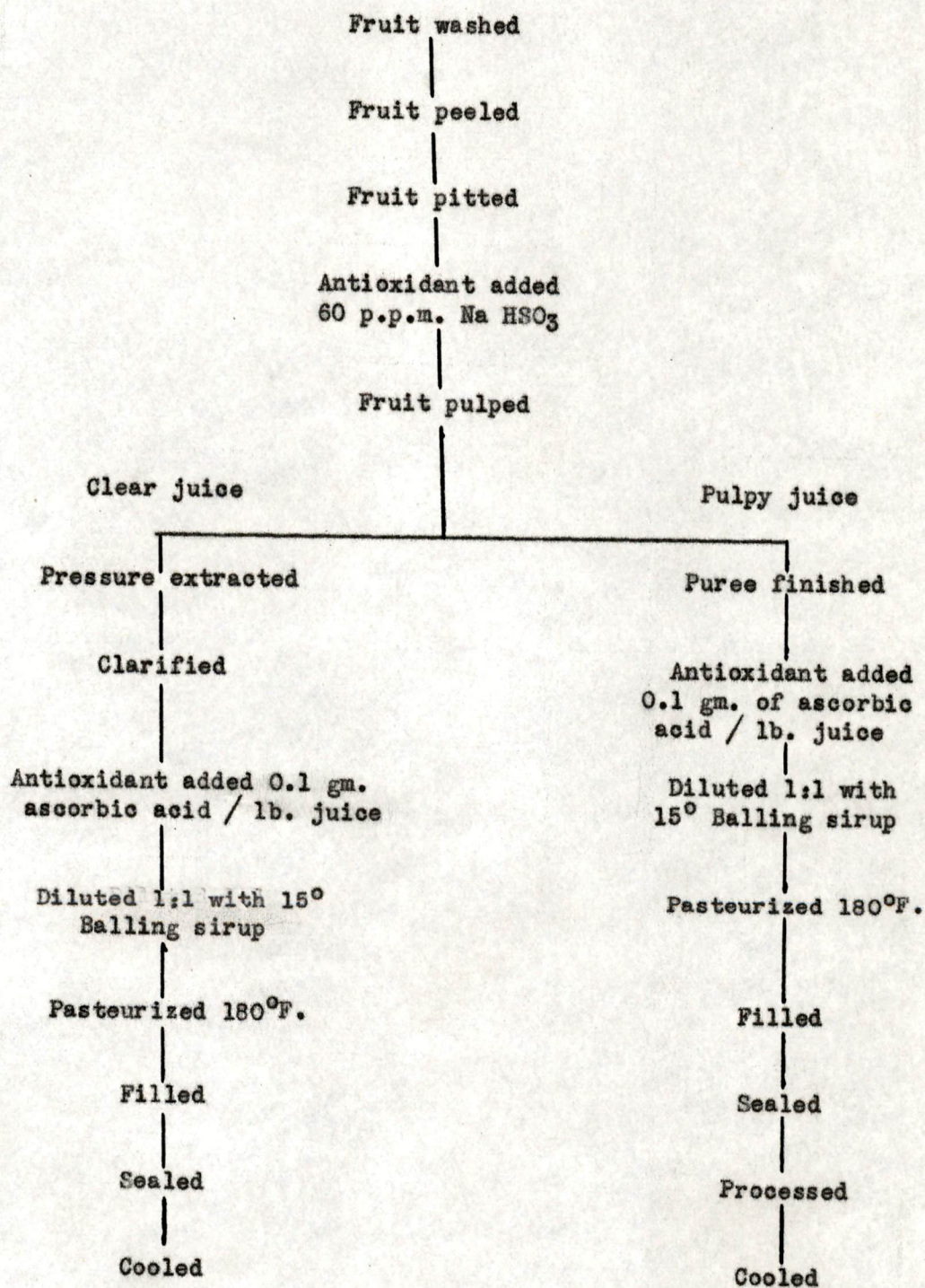
was stored in a cool dark place and the frozen juice was stored at 0°F. in a freezer-cabinet unit.

Since the American taste is so cultivated, blending of the prepared pulpy and clear juices was tried in an attempt to find a flavor more acid or tart which would be more appealing to the consumer. Blends of peach juice with juice of lemon, orange, grapefruit, apple, pineapple and Seven-Up and ginger ale were tried at numerous dilution ratios.

A summary of the general procedure is included in Table I of this report.

TABLE II

SCHEMATIC OF PEACH JUICE MANUFACTURE



RESULTS AND DISCUSSION

Experiment I

The primary purpose of this experiment was to study and compare the effect of different methods of preparation upon the yield, appearance, flavor and quality of juice obtained. Secondly, it was hoped the experiment would afford some insight on the structure and composition of the fruit, the presence of undesirable constituents and the difficulty entailed in separation of the juice.

Much has been said concerning the varietal differences of fruit, the influence of locality and conditions under which it is grown and the maturity and condition when used. Varietal differences, especially in regard to appearance and flavor, are easily apparent and highly important. The yellow-flesh varieties were decidedly superior to the white-flesh variety in appearance and flavor. While less apparent, the results indicate that the later maturing varieties of Early Elberta and Elberta yield juice of better flavor than the early maturing varieties used in this experiment.

Size of the fruit did not affect its desirability for juice manufacture provided it was sound. However, the pits make up a greater percentage of the total weight in smaller peaches. Likewise, the time and labor involved in pitting on a commercial scale would also be a factor to consider.

While no carefully measured yield results were considered necessary, general yield indications from the various methods of preparation tried

show that the peeled, pitted, heated to 165°F. and pulped fruit gave the highest yield of juice. The peel was found to hinder the rupturing of the juice sacs and to impart a somewhat bitter flavor to the juice. The presence of the pits also resulted in decreased yield as well as provided a source for bits of broken or crushed seed or pit to get into the juice. The yield secured with the whole fruit was even lower as the collective influence of the peel and pits tended to reduce both the amount of juice and the ease with which it was obtained.

Results, as shown in Table III of this experiment, indicated that peeling increased yield by facilitating extraction of the juice and preventing impairment of its flavor; pitting increased yield by permitting the juice cells to be more easily and completely ruptured as well as preventing the incorporation of bits of the pit or seed into the juice or pulp; heating increased yield by coagulating or liquefying the gummy, pectic substances surrounding the juice cells and causing the juice to run freely; and that, pulping increased yield by mechanically rupturing the juice cells thereby making extraction easier. Similar results were obtained when this experiment was later repeated, therefore, in the following experiment only this method of preparation was used.

Supplementary observations showed that, although the peach is from 83 to 88 percent moisture by weight, considerable difficulty would be encountered in extracting the juice due to the physical nature of the peach. The removal of the peel and pit were problems peculiar to the

TABLE III

METHODS OF PREPARATION AND THEIR INFLUENCE
UPON QUALITY AND YIELD OF JUICE

Treatment	Quality	Yield
Peeled	Improved	Increased
Unpeeled	Impaired	Reduced
Pitted	Improved	Increased
Unpitted	Impaired	Reduced
Heated	Improved	Increased
Unheated	Impaired	Reduced

peach. The cellular structure of the peach, cells encased in pectinous skins, was responsible for difficulties in recovering the juice. The juice was found to be enclosed in tiny sacs, oval to round in shape, which formed a gelatinous mass, making mechanical extraction difficult. These results, as expected, were in complete agreement with those reported by Bentley (1947). Browning, discussed elsewhere in this report, was encountered and emphasized the importance of speed in handling all operations.

The results also indicated that a considerable portion of the peach responsible for the flavor was contained in the pulpy material and, consequently, is not present in the clear juice. Since pulpy particles were largely responsible for the flavor of the juice, it was apparent that experiments with a pulpy beverage would be mandatory.

EXPERIMENT II

Some of the workers in this field have found extraction of the juice to be difficult. In this experiment two methods of extraction were applied to the peach pulp prepared by peeling, pitting, heating to 165°F. and pulping, as this was found the best method of preparation in Experiment I. Detailed yield studies were made of the high pressure tests and are reported in Table IV and Figures 1 and 2.

Having selected a method of preparation believed to be the best, pressure extraction studies were initiated using a cider press. These preliminary studies soon showed that a yield of from 30 to 32 percent

TABLE IV

AVERAGE YIELD OF JUICE USING HIGH PRESSURE

Ingredient	Quantity
Pulp	1129.4 gms.
Juice extracted	985.0 gms.
Percentage yield	87.2 %
Pressure attained	14000.0 lbs. per sq. in.

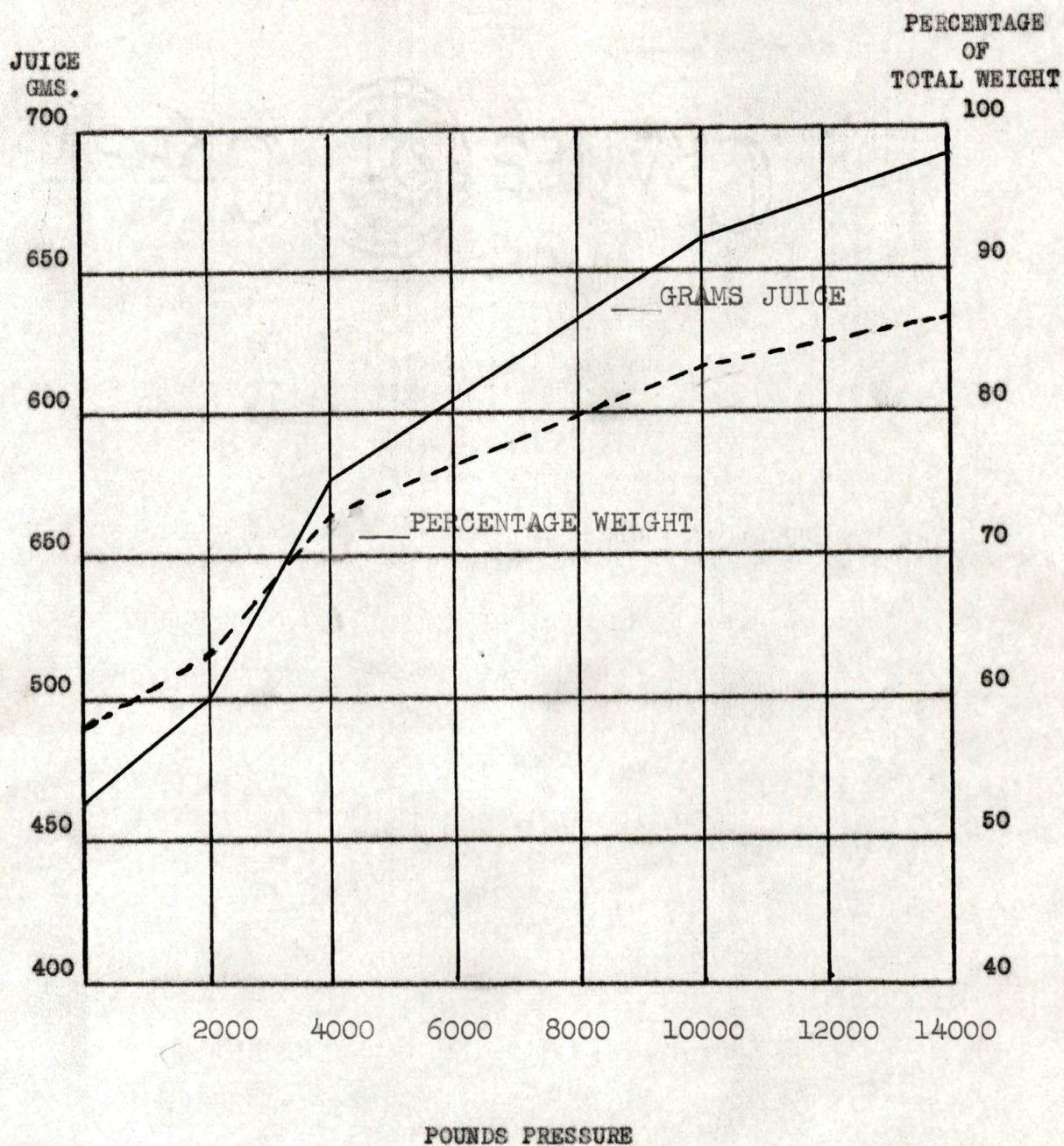


FIGURE 1

THE EFFECT OF PRESSURE UPON YIELD OF JUICE FROM 791.8
GRAMS OF PULP

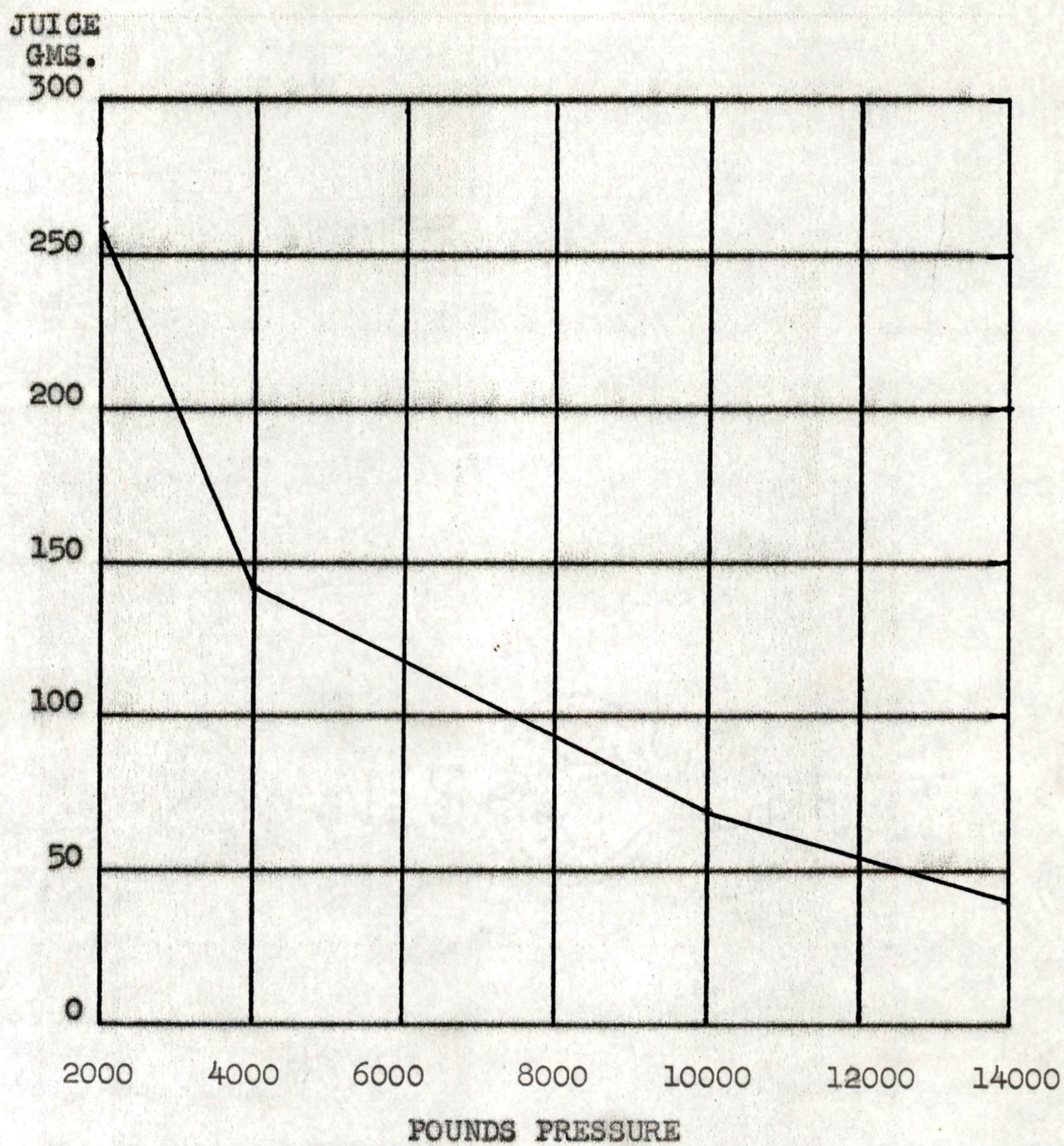


FIGURE 2

YIELD OF JUICE PER POUND OF PRESSURE APPLIED
USING 791.8 GRAMS OF PULP

could be obtained fairly easily but that higher yields did not result from increased pressure. In fact increasing the pressure appeared to have a retarding effect on further extraction by closing the filtration channels. Results from these early attempts to utilize the cider press in extracting the peach juice led to the decision to abandon its use and to make further studies utilizing relatively high pressures.

In an effort to determine the effect of pressure under controlled conditions and to study high pressure extraction more thoroughly, the pilot extractor of the chemistry laboratory was used. With this pilot extractor, pressures ranging up to 14,000 pounds per square inch were applied to weighted quantities of pulp. The yield of juice obtained with the high pressure ran as high as 87 percent by weight. The residue from the pressing could be easily pulled from the press cloth in layers and resembled the peel although somewhat thicker.

The influence of increased pressure upon juice yield is shown in Figure 1. The curve shows an increase in yield with an increase in pressure but the increase in yield is not constant with proportional increase in pressure. Figure 2 used the same results plotted in yield per pound of pressure applied. From the curve, it is evident that there is a gradual decline in the amount of juice secured per pound of pressure applied.

The expressed juice obtained was clear but did not have a very pronounced characteristic peach flavor although it contained upon extraction 9 percent total solids as determined by the Brix test. Since there seems to be a growing opinion among investigators that typical fruit

flavor is the most important characteristic of high quality juice, this clear juice, obtained by pressing, left much to be desired in flavor.

EXPERIMENT III

Having determined that the pulpy juice offered the best possibilities, attempts were made to further improve the appearance and stability of the juice. From preliminary studies with the pulpy juice, it was found to be very unstable. This characteristic gave impetus to a series of studies.

Although the pulpy juice might appear homogenous in nature when processed, upon standing a few hours breaks occurred and the mass separated into alternating layers of pulp and relatively clear juice. Even after standing for several days, the specific gravity differential was not great enough to bring about complete separation by sedimentation. Some of the heavier pulp material did settle out but other portions remained floating on the surface or suspended in stratified layers throughout the medium. Carrageen extract was used in the amounts of 0.1, 0.5 and 1.5 percent by weight in an effort to stabilize the juice. The addition of 0.1 and 0.5 percent did not result in any favorable increase in stability. With the 1.5 percent test, the pulp settled considerably before the entire material formed a gel-like mass.

This unpredictable nature of the pulp caused the plan of this experiment to be changed to include clarification studies for the purpose of producing a cloudy or semi-clear juice. Centrifugal separation was tried but did not prove successful probably due to the low specific

gravity differential already mentioned. Sedimentation and decantation were likewise eliminated for the same reason. Exploratory precipitation trials were initiated but none seemed to merit further study. Enzymatic decomposition of the pectin was not attempted because reports by other workers indicated that the fermentation which developed during the time interval necessary for "anti-pectin" action could not be tolerated.

Finally, filtration tests were tried. Various cloth, paper, fine wire screens and commercial milk filters made of layers of paper and cotton were used. The cloth and milk filters gave a fairly good cloudy juice. The addition of fuller's earth as a filter did not result in any improvement of the filtered juice. In fact, the fuller's earth could not be entirely removed from the cloudy juice and thus resulted in an adulteration as well as discoloring the juice.

However, when tested organoleptically, the cloudy or semi-clear juice did not possess a strong characteristic peach flavor. The peach flavor seemed to vary in direct relation to the amount of pulpy material the juice contained. These results led to the decision that despite its instability, pulpy juice, which has been finished by passing through a coarse filter cloth or fine mesh screen thus reducing the size of the pulp particles as much as practical, offered the best possibilities since it possessed by far the best peach flavor.

The instability of the pulp was not the only fault revealed in the appearance of the juice. Browning was found to occur quite readily. In fact, almost every operation in the manufacture of peach juice tended

to increase browning. Exposure to air during peeling and pitting resulted in browning. In pulping the peaches, air is incorporated into the product and browning is increased. The process of extraction was very favorable toward the development of browning.

Although the fruit is heated to 165°F. prior to pulping, this treatment cannot be expected to completely inactivate the enzymatic system responsible for browning. Hence, the addition of sodium bisulfite to the fruit prior to pulping was tried as sulphur dioxide is known to be effective in controlling browning. In the experiment, additions of 30 to 60 parts per million of sodium bisulfite were made. The 60 parts per million of bisulfite gave the best control and is believed very desirable for adding to the fruit prior to pulping as the cost is not prohibitive. The tartness of the peach, due to the presence of tannins or other astringents, tended to mask the taste of any residual sulphur dioxide in the finished product.

The addition of ascorbic acid to fruit juices has also been proven an effective means of retaining its flavor and color. Consequently, it was believed desirable to add some ascorbic acid to the finished juice as a further aid to browning control. Ascorbic acid may be added to fruit juice in sufficient quantities that it may furnish a substantial portion of the required Vitamin C of our diet. Such levels of ascorbic acid accomplish Vitamin C enrichment as well as the retention of the color and aroma of the juice. However, the cost of ascorbic acid at such levels was believed to be too great for the purpose of this

experiment. Hence, the standard amount of 0.1 gram of ascorbic acid per pound of juice was used throughout this experiment. The ascorbic acid, at the rate of 100 milligrams per pound of juice was added to the vessel used in collecting the juice from the pulper. Results indicated that the addition of ascorbic acid at this level was very effective in preventing the oxidation of the catechols and tannins of the peach. The results are shown in Table V.

EXPERIMENT IV

Finally, the activities of the agencies responsible for the spoiling of the juice must be considered. Many early attempts to produce a quality fruit juice ended in failure because the pasteurization process used resulted in a "cooked" or pasteurized flavor which consumers would not accept. Thus, it became apparent that the microorganisms and enzymes responsible for spoilage should be destroyed with a minimum effect on flavor.

Early workers had recommended that the diluted pulp be boiled. Some of the diluted pulp was boiled in this experiment but the results, as expected, were very unfavorable. This heating to the boiling point resulted in the loss of most of the volatile aromatic constituents responsible for the peach flavor and odor. Consequently, the resulting juice was very flat in taste and did not contain the peach flavor and odor desired.

Flash pasteurization, developed in the citrus industry, has been adopted by the fruit juice industry. However, such equipment was not

TABLE V

EFFECT OF SODIUM BISULFITE AND ASCORBIC ACID
ON APPEARANCE OF THE JUICE

Sample	Treatment	Rating	Remarks
1	None		Control group
2	30 p.p.m. sodium bisulfite	X	Inadequate control
3	60 p.p.m. sodium bisulfite	XX	Fair control
4	30 p.p.m. sodium bisulfite plus 100 milligrams ascorbic acid	XXX	Good control
5	60 p.p.m. sodium bisulfite plus 100 milligrams ascorbic acid	XXXX	Excellent control

available for this experiment. In view of this limitation, the application of heat for preservation was confined to pasteurization at 180°F. for twenty minutes, after which, the sealed, pulpy juice was subjected to a five minute process in a boiling water bath as the heat penetration in the pulpy juice was much slower. The resulting juice, when prepared in this manner, was far superior in flavor and odor to the juice subjected to boiling temperatures. Despite this improvement in quality, the resulting juice did not possess a strong characteristic peach flavor and odor. From these results, it was concluded that this lack of flavor and odor was probably due in part to the fact that even the fresh peach juice does not possess a strongly characteristic flavor and odor. Consequently, any method of processing could not be expected to improve upon the original quality of the fresh juice but rather be almost certain to lose some of the fresh juice qualities at best.

Some preservation by freezing was tried. The frozen product was superior to the canned product. However, the freezing method, being more expensive than the canning method, was not studied to any great extent because it was believed that, to be successful commercially, the peach juice must be adaptable to the cheaper method of preservation since competition is rather keen in the fruit juice field. Another reason behind the abandonment of freezing trials was the fact that browning was more serious in the frozen than in the canned product thus requiring more of the expensive antioxidant ascorbic acid. Finally, de-aeration, which was believed desirable prior to adding the ascorbic acid, was not possible due to lack of facilities.

In view of the fact that the resulting juice left much to be desired in flavor and appearance some supplementary blending and artificial coloring work was attempted. Blends of the peach juice were tried in numerous ratios with lemon, orange, grapefruit, apple, pineapple, Seven-Up and ginger ale. In these obviously limited blending trials, results again emphasized the lack of a strongly characteristic peach flavor in the juice. All of the blending agents tried, if used in any appreciable amount, masked completely or altered the peach flavor and odor beyond recognition. Artificial yellow coloring was added to the peach juice and resulted in a more pleasing color although, of course, did nothing to enhance flavor and odor.

CONCLUSIONS

From the results obtained in the preceding experiments, it seems reasonable to assume the following conclusions:

1. The more highly flavored yellor-flesh varieties were best for making juice.
2. The method of preparation yielding the highest quality juice included peeling, pitting, adding 60 parts per million of sodium bisulfite, heating to 165°F. and pulping.
3. Pulping without removal of peel or pits resulted in decreased yield and poor quality juice.
4. Attempts to extract the juice with a cider press failed to prove successful.
5. The high pressure extraction gave yields of 87 percent by weight of juice.
6. Pulpy juice contained more flavor than clear.
7. Pulpy juice diluted 1:1 with 15° Balling sirup was the most promising juice.
8. Browning was a problem in almost every operation.
9. Addition of 60 parts per million of sodium bisulfite to the fruit prior to pulping and supplementing with 100 milligrams of ascorbic acid per pound of juice gave the best browning control.
10. Fuller's earth did not aid in clarification studies.
11. Fermentation was a problem in working with peach juice.
12. Pasteurization at 180°F. was the best heat treatment for preservation as boiling destroyed the flavor and odor.

13. Blending attempts failed because of the relatively weak peach flavor and odor of the juice.

14. Pulpy peach juice prepared in this experiment did not possess very high quality or very strong peach characteristics.

15. The pulpy peach juice was unstable.

On the basis of this experiment, peach juice did not appear to possess strong commercial possibilities. However, the possibilities of producing the pulp to colloidal size was not studied. De-aeration and flash-pasteurization could possibly change the results. Likewise, the blending possibilities were far from exhausted, the addition of peach essence was not attempted, and freezing possibilities could prove to be the solution.

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