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Effect of Sweeteners on the Acceptability of Selected Processed Fruits

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EFFECT OF SWEETENERS ON THE ACCEPTABILITY OF SELECTED PROCESSED FRUITS

by

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Richard L. McLaughlin

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INTRODUCTION

In 1959 Abbott Laboratories estimated (3) that every year 60 million persons go on controlled diets. Of these about 34 million have serious obesity problems, 3 million are diabetics and the rest have disorders that demand strict dietary measures.

In past years, the medical practice recommended that for persons suffering from diabetes mellitus has been to eat only foods almost completely devoid of available carbohydrates. Only recently, have physicians advocated a more balanced diet. Even so, total food intake must be regulated to be able to calculate for the required amount of insulin. Restrictions for the obese person do not eliminate all carbohydrates, but prevent excessive consumption of high caloric foods above the total daily energy requirements.

For those who must restrict their carbohydrate or total food intake, certain dietic products are available on the market today. These products have been processed with water or with a synthetic sweetener. However, the taste of most of them is rather bland. In recent years there has been an increase in consumption of fruit due to their being recognized as necessary to good nutrition. High quality and low calorie processed fruit or fruit products will increase the market and be another outlet for processed fruits and fruit products.

Acceptability of a given product is mainly based on three qualities—appearance, texture, and flavor, and forms the basis of judgment for a product. People judge a product by these qualities whether or not they are aware of them. The quality by which a product is judged first is its appearance as to characteristic color, shape, and eye appeal. A fruit loses its texture as its tissues become soft when processed in water or with synthetic sweeteners alone. In this respect the use of sucrose is important as it tends to strengthen cell walls, making the texture more like that of the fresh product, hence more acceptable. Finally a sharp light flavor is generally more acceptable than a bland heavy one.

The qualities of those products processed in sucrose and synthetic sweeteners are quite different not only in flavor but in texture. By combining the best qualities that these sweeteners impart to the fruit, a lower calorie food may be produced for the dieter which is still acceptable in other respects for other members of the family.

The work of this thesis was conducted to determine what combination of sweeteners would produce the most acceptable pack. Several concentrations and combinations of sucrose, calcium cyclamate, calcium saccharin, and hexamic acid sweeteners were used in the processing of cherries, apricots, peaches, and pears. A consumer panel of townspeople consisting of at least 20 families (117 individuals), and a laboratory panel of 10 trained individuals), and a laboratory panel of 10 trained individuals evaluated the products for flavor, color, texture, and other attributes. Objective tests of drained weight, pH, soluble solids, and color differences were also taken.

REVIEW OF LITERATURE

A review of pertinent literature was made for information concerning quality, nutritive value and acceptability factors involved in the processing of fruits in sweeteners. The review was made also for the use of taste panels and objective tests of color, pH, drained weights and soluble solids. This data will be grouped under the headings of Preparation Factors and Quality Evaluation Factors.

Preparation Factors

Selection of fruit

The selection of the fruit as pertains to the quality, nutritive value and acceptability depended on location, variety, and personal tastes. The quality of fruit to be processed was kept high by selection of those varieties which would lend themselves well to the particular type of processing to be done.

Nutritional values. Some persons have promulgated the false idea that the food value of some crops have been demineralized or lack the proper nutrients because they have been grown on poor soil. Mitchell (25) and Nelson (26) showed that the composition of crops grown on nutrient depleted soils is no different than those grown on well fertilized soils, except that the yield is not as great. Fruit contains many of the nutrients that are necessary for good health. They not only add nutritive values to a meal, but are needed for flavor, appetite appeal and variety in our meals.

Diabetes and obesity. The adequate diet will vary with the individual and the type of work he performs. However, there are many persons in the United States that either are or should be on restricted diets. Only two types will be discussed here. According to Seeman there are approximately 3 million diabetics in the United States and half of them are undetected (37).

Diabetes is a disease in which the body does not produce any or a sufficient amount of insulin. It is not contagious, but the succeptibility to diabetes is inherited as a Mendelian recessive characteristic (18). These tendencies under normal conditions may never develop, but under prolonged environmental stress, emotional disturbances, or obesity, the disease has the greatest chance of manifesting itself.

Although people as a whole cannot control their environment, or some emotional disturbances, obesity can be controlled. Not every overweight person becomes diabetic, but eight out of 10 diabetics were overweight when they developed the disease.

Obese persons who may not have diabetic tendencies still have a health problem. Obesity is deleterious and is associated with premature death, and an obese person may develop hypertension, degenerative cardiovascular disease, and other disorders (18).

Conway (10) indicates that nine out of 10 obese persons have an emotional or psychological problem. To the obese person, food may substitute for love, security, or be used to relieve nervous tension and he may indulge in more food than is good for health. Pangborn and Simone (27) found that obese persons tend to like all foods in general rather than sweet foods in particular. A return to a low blood sugar level appears to occur faster in persons who are gaining weight than those of normal weight, thus causing a more transient satiety (1). A Mayo Clinic Diet Manual (22) table shows the foods and their caloric values commonly consumed between meals. Only four fruits are shown and no vegetables, indicating over consumption of high caloric foods.

Sweeteners

The cover syrups at present are defined in a United States Department of Health Education and Welfare publication (44). This shows the limits, ingredients and proportions for the syrups of the final commercially packed product.

Sucrose. Sucrose ($C_{12}H_{22}O_{11}$) because of its wide usage is the standard sweetener and has been assigned the relative sweetness rating of 1. It is the basis of all nutritive cover syrup in the canning industry. Sucrose is used not only for the sweetening power, but according to Erickson and Fabian (11) for its preserving and germicidal effect on yeasts and bacteria. The higher the concentration the greater its germicidal effect, however, the intensity of the sucrose solution masks or interferes with flavor perception (45, 28).

Sucrose also has a toughening effect on the fruit tissue as was observed by Sterling and Chichester (40).

Saccharin. Saccharin, ($C_6H_4COH \cdot SO_2$) the first of the non-nutritive sweeteners to be produced commercially and in wide usage until 1950 has been reported (34) to be 300-550 times sweeter than sucrose in dilute solutions. As early as 1912, as far as could be determined under past methods of study, saccharin was not injurious to the health of man. In 1955, the Food Protection Committee (32), conducted further investigations on saccharin and cyclamate with the same results as previously determined.

Cyclamates. The formula for calcium cyclamate is $(C_6H_{11}NHSO_3)_2 \cdot Ca \cdot 2H_2O$, and for the sodium cyclamate is $C_6H_{11}NHSO_3Na$. These are both approximately 30 times sweeter than sucrose. Both cyclamates have been shown to be stable under all canning procedures and heating does not produce any off-flavors (34). Beck (4) indicates that cyclamates did not carmelize, and did not break down by heating to 500 degrees C. It did not serve as food for bacteria. Kames (17) studied the interaction of sucrose and cyclamate calcium, and found that at intermediate ranges, the sweetness was intensified. Schutz and Pilgrim (36) showed that sweetness of sugar solutions increased with the concentration, whereas synthetic sweetener solutions decreased in sweetness as the concentration increased.

Calcium Cyclamate has a firming effect on the flesh of the fruit. It was found by Joslyn et al. (16) and that the calcium content of water, lye, and other calcium sources was cumulative and that calcium at 50 parts per million had the greatest firming effect.

Quality Evaluations Factors

Two types of testing can be performed to evaluate the properties of food to be consumed: subjective and objective testing.

Subjective tests

Any test whereby a personal bias may enter into the conclusion or judgment upon a subject is considered a subjective test.

Sensory perception. The five senses are used in all phases of food production and usage. McLean (24) showed the importance of preparing meals that appeal to sight, smell, and taste, which are colorful and served from tables that are attractively set. Krause (18) illustrated that patients in hospitals eat better when an attractive tray is presented as compared with an ordinary tray without decorations or eye appeal.

The next three senses are each a separate and distinct quality, but are so interrelated with food that many people combine them under one title as "taste."

Beidler (7), Pfaffmann (31), and Pettit (30) have shown the roles that physiology and psychology play in the complex qualities of flavor.

Pettit (30) conducted several tests to determine the psychological influence on flavor by presenting panel members with cups of tomato juice from a common source. The cups were marked differently and a list of statements were given indicating the addition of substances besides the tomato juice. The results showed that the information conveyed to tasters had meaning within terms of their experience, but if the information did not have meaning it might not affect their judgement.

Physiologically, taste has only four qualities; salt, sweet, bitter and sour (7, 29). These qualities are distinguished in the oral cavity by taste receptors, presumably by fine hair like projection located in and extending from the fungiform papillae or taste bud on the tongue. The taste buds or papellae as Beidler (6) has examined them are comprised of 20-30 cells innervated by several nerve fibers. Beidler et al. (6) have shown by flowing certain chemicals across the tongue that a different response is recorded with different chemicals, and with increasing concentrations an increase in magnitude of response is noted. McLean (24) has shown by mixing salt and sweet or other combinations that a difference in response is distinguishable.

Odors are associated with taste. These combinations are termed flavors. The physiological makeup of the odor organ is described by Patton (29) as being located in the top of the nasal cavity. The mucosa out of which extend the olfactory hairs, is approximately 2.5 cm across.

Beidler (7) states that basic study in olfaction is far behind research in other sensory fields and that the knowledge on which to organize theories of flavor preception is limited. Where there are thousands of taste receptors there are millions of olfactory receptors thus making the flavor perception by these two means a complex and intricate process.

Taste panels. There are at least three specific purposes for which taste panels are set up. First is a panel to distinguish any off flavors or characteristics of the specific product. This type panel was not used for this study. Second is to distinguish degrees of differences in flavor but not necessarily for any given product. Third, a consumer panel or a cross section of all potential customers to determine acceptance of a new product (23).

Hokenson (15), Bennett, et al. (8) investigated the value of training a panel and found that their ability to produce consistent results was greatly improved. Gerardot, Peryam, and Shapiro (13) used several panels and found that a general purpose panel is adequate when precision must be sacrificed to save time and labor.

There are many ways of presenting samples for judging to a panel. Laboratory panels judge by pairing, scoring, ranking, or combining the latter two methods. Consumer panels use techniques such as: blind and identified paired comparison, blind and identified monadic, scaling devices, and small market place tests (46).

Objective tests

Objective tests are those whereby personal bias does not or cannot enter into the judgement. The objective tests concerned in this study were as follows:

pH. The knowledge of pH is important in the preserving process of canned goods; for example, plums may be sterilized in 10 minutes at 169 degree F. while string beans require 4 hours at 212 degree F. This is because of the hydrogen ion concentration and its effect on bacteria. Bacteria are killed more readily in acid solutions than in non-acid mediums.

The pH of a product which will classify it as either an acid or non-acid food, has been set at 4.5 (12). Most all natural biological solutions are buffered. A buffered solution is one in which the ions are inconsistantly disassociated at different levels of concentration. To measure the hydrogen ions in a solution there are two methods; colorimetric and electrometric systems of which the latter is more accurate (39).

Hunter Color and Color-difference values. Several methods have been devised to aid in eliminating the personal bias in recording color on fruit and fruit products but nearly all devises retain a certain amount of subjectivity. The Hunter Color and Color-difference meter uses a method by focusing a light source to reflect light off the object to three filtered photocells which causes an electric current to flow to a galvinometer (2). The amount of light reflected is related to the color.

Drained weight. Many factors influence drained weight. Luh, Leonard, and Mrak (21) listed some of these factors as storage time, concentration of cover syrup, fill weight, ripeness level, and growing area. In their study they showed that during storage time the drained weight increased rapidly during the first week and then more slowly until a maximum was reached in 90 days. They also found that the riper the fruit the lower the drained weight and that increasing the concentration of cover syrup over 40 degrees Brix would decrease the drained weight. Ross, (33) in studying the translocation of sugars and water in canned fruit found that recovery time was influenced by the type of syrup. One variation was that the sugar with the highest molecular weight showed the least sugar translocation into the fruit. Leonard, Luh, and Mrak (19) found that fill weight and ripeness level were important factors. The general purpose of drained weight is to control a variable for the determination of grades for U.S.D.A. standards (42,43).

MATERIALS AND METHODS

The research was conducted for two years. The preliminary studies were conducted in 1959-60 to determine the best combination of fruit and solutions to be tested on a larger scale during 1960-61.

All the fruits for the two years were obtained from the Howell Field Station of the Utah State University Agriculture Experiment Station at Pleasant View, Utah.

The fruits were selected according to size, color and maturity. To minimize variations, they were obtained from as few trees, and as near to the same location as possible.

The sweetening agents used were obtained from three sources: Sucrose from Pacific Fruit and Produce Company at Logan, Utah; calcium cyclamate (*n*-Cyclohexylsulfame acid), hereafter will be referred to as cyclamate, and hexamic acid were secured from Abbott Laboratories of Chicago, Illinois; and sodium saccharin (*O-sulfabenzoic acid imide*) hereafter will be referred to as saccharin, was received from Monsanto Chemical Company of St. Louis, Missouri.

Preliminary Study (1959-60)

It was decided that for the preliminary study, a large selection of fruits and several concentrations of the sweeteners would be evaluated to determine the most promising combinations for the second years study. The fruits for the preliminary study were: Bing, Lambert, Napoleon and Windsor cherries; Large Early Montgamet (Chinese), and Moorpark apricots; Red Haven, and Elberta peaches; and Bartlett pears. Enough fruits of each variety were obtained for three replications.

Twelve solutions at these concentrations were used for all the fruits except pears: 60, 50 and 40 per cent sucrose; 1.50, 1.25 and 1.00 per cent for each synthetic sweetening agent of cyclamate, saccharin and hexamic acid. When the concentrations of the synthetic solutions proved to be too strong for one of the peach varieties, an additional nine solutions were prepared at the reduced concentrations: 0.30, 0.20 and 0.15 per cent each of cyclamate and saccharin; and a combination of cyclamate and saccharin in proportions of 10 to 1 respectively at the above concentrations.

Preparation and processing of material

General preparations. Methods of preparation were removing pedicels from cherries, pitting of apricots and peaches, peeling the peaches, and peeling and coring the pears. The procedures common for all fruits were washing then draining for two minutes, weighing with a gram scale the allotted amount of fruit to be placed in a 2½ size tin can, measuring the various solutions into the coded cans (Figure 1a), sealing them with a Pacific No. 1 Semi-Automatic Vacuum Closing machine (Figure 1b), exhaused the cans to 17 inches of mercury, and cooking the cans of fruit in a Master Retort 100 (Figure 1c) for the

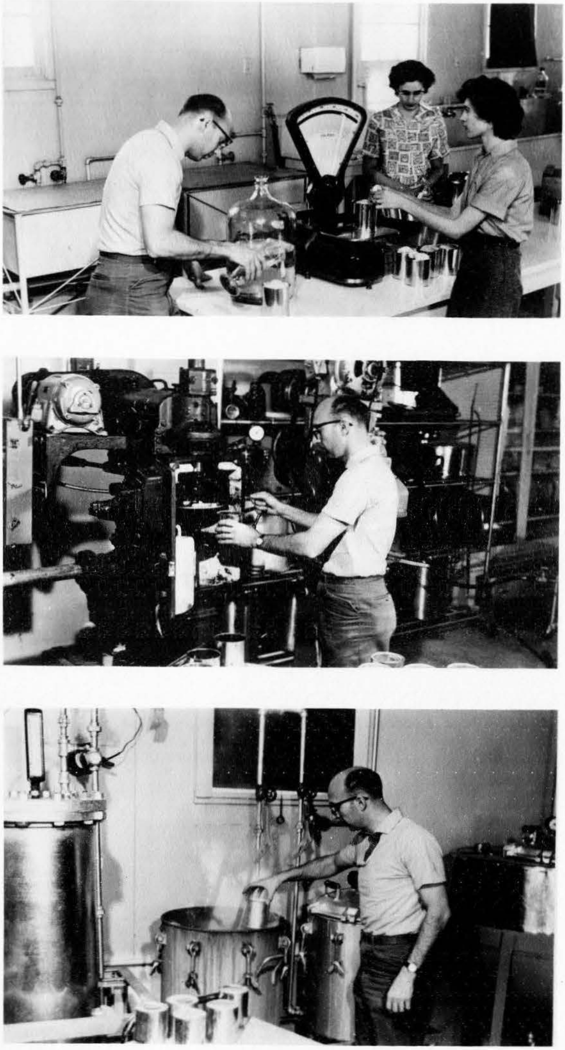


Figure 1. a. Preparing, weighing, and syruping the fruit for processing
b. Sealing the cans in the Pacific No. 1 Semi-automatic closing machine
c. Cooking the fruit in the Master Retort 100

period of time specified (41) for each particular fruit. All the cans were stored at room temperature until January of the following year.

Specific preparations. There was enough difference in size and weight between varieties that the proportions of fruit and solution varied.

Four varieties of cherries were processed in cans lined with r-enamel in the following proportions of fruit and solution: Bing-367 grams of fruit and 300 ml. of solution per can for the first 12 solutions mentioned above. Lambert, Napoleon, and Windsor-430 grams of fruit and 400 ml. of the same 12 solutions.

There were two varieties of apricots. The plain cans that were coded for Large Early Montgamet received 450 grams of fruit and 300 ml. of solution, and those marked for Moorpark received 505 grams of fruit and 300 ml. of solution. Only the first 12 solutions were used on the apricots.

Red Haven peaches were packed in plain cans, each can received 575 grams of fruit and 250 ml. of solution.

Upon opening some of the cans it was found that the solutions of the synthetic sweeteners were too concentrated; therefore, the decision was made to prepare the nine additional solutions as mentioned before.

The Elberta peaches were treated in the same manner and proportions as the Red Haven peaches except that the nine additional solutions were used.

A different group of solutions was used for the Bartlett pears which consisted of a combination of 40 per cent sucrose plus 0.15 per cent cyclamate or saccharin. Decreasing proportions of the 40 per cent sucrose solution from 325, 240, 162, 85 and 0 ml. were intergraded with 0, 85, 162, 240 and 325 mls. of the 0.15 per cent cyclamate or saccharin. Plain tin cans were filled with 521 grams fruit and 325 ml. of the intergraded solutions.

Quality evaluations of material

To evaluate the processed products, various machines and equipment were employed for objective tests; and a taste panel of 10 trained judges was used for subjective tests. Since the methods and equipment were the same for both years work, to avoid repetition, the methods will be described in detail in the second years work.

Second Year Study (1960-61)

As a result of the previous study, seven solutions and four fruits were selected to be used for the more extensive study during 1960-61. The solutions were 60, 50 and 40 per cent sucrose; 0.15 per cent cyclamate; 0.05 per cent saccharin; and two solutions which contained a combination of sucrose plus synthetic sweeteners: 10 per cent sucrose plus 0.1 per cent cyclamate, and 10 per cent sucrose plus 0.02 per cent saccharin.

The fruits selected for this project were: Bing and Lambert cherries, Large Early Montgamet apricots, and Elberta peaches.

Preparation and processing of material

General preparations. The general preparations were the same as those explained in the prelininary study.

Specific preparations. The proportions of each fruit that was placed in the cans were Bing and Lambert cherries—480 grams of fruit and 375 ml. of solution. The Large Early Montgamet (Chinese) apricot proportions were allotted 450 grams of fruit and 375 ml. of solution per can for the various sweeteners and their concentrations. The Elberta peaches also were processed with 450 grams of fruit and 375 ml. of solution per can.

Quality evaluations

Consumer panel. To evaluate the products for this experiment, a consumer panel of townspeople in addition to a trained panel were used to judge their acceptability. The panels were told that they would be judging fruit that was processed according to the standards prescribed for commercial processors, and that they would be aiding an experiment being conducted at the university, but they were not told how the fruit was processed.

The consumer panel of townspeople was chosen from an area of one-half mile square. This area was representative of the populace inasmuch as after the final choosing the panel contained a doctor, lawyer, janitor, plumber, employees, employers, home owners and renters, from high to low income families.

As an aid in making a randomized selection, a list of 50 families was compiled and from this list 20 were chosen to participate. There was one stipulation, however, that the family must contain at least three children over six years of age. The final panel consisted of 20 families and totaled 117 persons whose ages ranged from six to 65.

The cans were coded with a number and a letter to correspond to the fruit and solution contained within and a sample number. An envelope, an instruction sheet, and sufficient individual ballots were all marked with the sample number corresponding to the can to which they were attached.

Figure 2 shows the ballots and instruction sheets attached to the cans. The ballots contained the following information: "circle one; Like, Dislike, Neither like or dislike; Would you buy this product if it were available? Yes, no, Comments." For sample ballot see appendix, page 75.

Four cans were delivered to each family every two days. A can of fruit was to be served at breakfast and one at supper for the two days. Each person was asked to mark his own ballot, although this was not always carried out. He was to put his name on the top of the ballot in the space provided and mark it according to his preference (Figure 3), then place all the ballots in the designated envelopes. When the next group of cans was delivered, the ballots from the former group were collected and tabulated.

Laboratory panel. The trained laboratory panel consisted of 10 individuals who had had experience with, and knew the characteristics of the fruits being sampled. These people were college personnel, five men and five women. They were given a tray containing four-five ounce dishes with samples of fruit in each, a glass of water, and a ballot (for ballot used see page 74), (Figure 4). Each member of the panel judged the fruit for flavor,

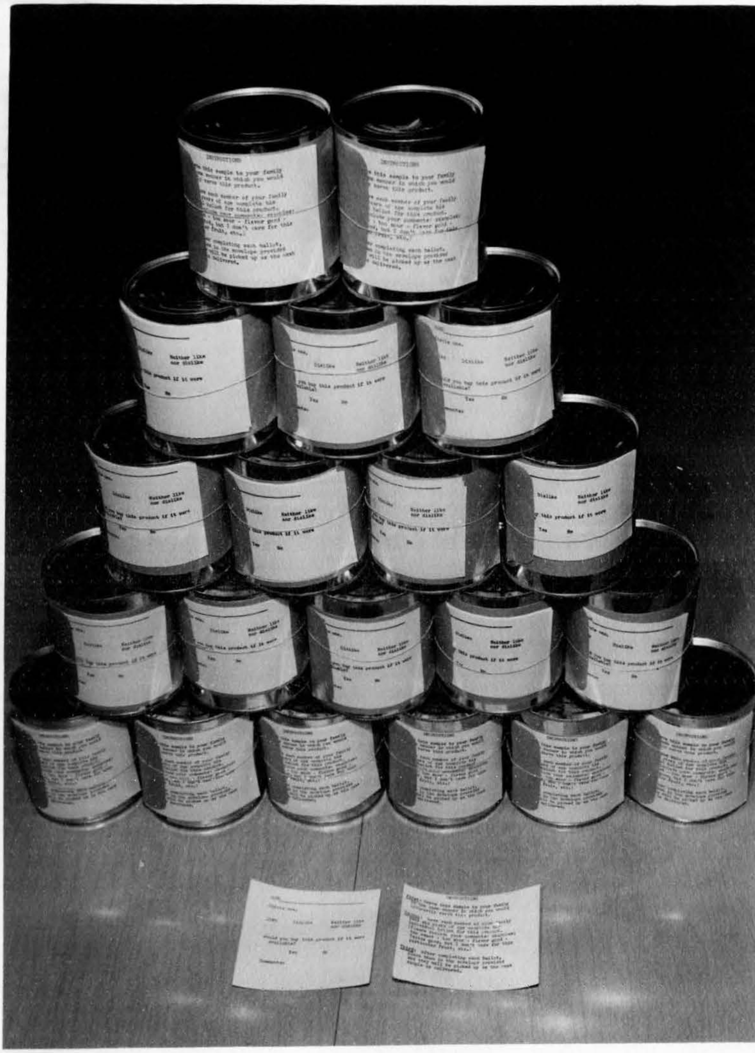


Figure 2. A sample ready for distribution to the consumer panel

Figure 3. A family of the consumer panel receiving instructions on the marking of the ballots

Figure 4. Sampling booth as prepared for the laboratory panel

texture and color, and off flavors (Figure 5). All laboratory panelist judged color from one subsample placed under two 400 watt daylight lamps inside the sampling room. The booths were in a separate room from where the food was prepared. Each booth contained a light, service for crackers, and waxed bags. As each panelist finished sampling, he gave his ballot to the administrator.

Cost evaluation. An attempt was made to compare the economic feasibility of processing fruit with sucrose by commercial packers, and with synthetic sweeteners. For unit cost comparisons see discussion.

Calorie evaluation. To explore the feasibility of using combination sweeteners, as this study is suggesting, a comparative chart was made to determine the calorie content of size 2½ cans of the fruits processed in the several sweeteners and their concentrations.

Objective test

Other tests conducted were drained weight, soluble solids, pH, and color differences to see if the processed products were comparable with the U. S. Standards.

Drained weight. The drained weights on processed fruits were ascertained by emptying the contents of the can upon a United States Standard No. 8 Circular Sieve, 12 inches in diameter with the screen 8 meshes to the inch. The screen was tilted slightly to facilitate drainage and allowed to drain two minutes. If the product had been halved and pitted, the peach or apricot pit cavities were turned down (42, 43).

Instructions for drained weights are found in the U. S. Department of Agriculture pamphlets: United States

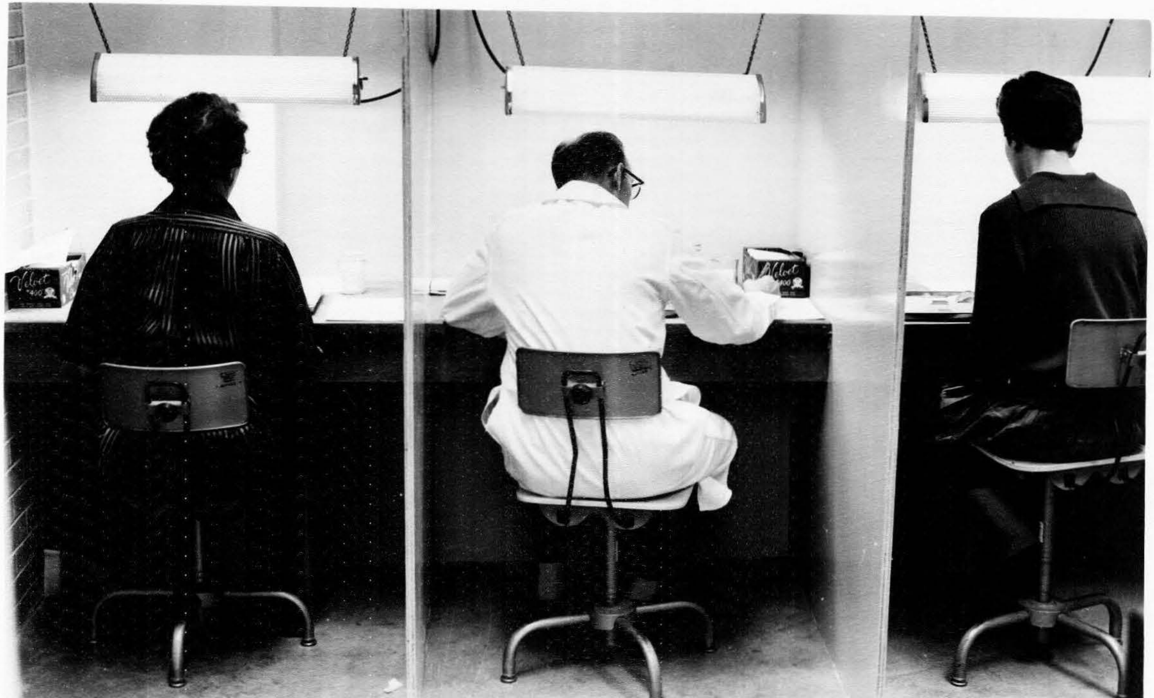


Figure 5. Laboratory panel members scoring fruit qualities

Standard for Grades of Canned Apricots (42), and United States Standards for Grades of Canned Freestone Peaches (43). These standards were used to determine if the canned product would meet U. S. standards.

Soluble solids. An Abbe-type refractometer was used to determine the amount of soluble solids that was contained in the fruit solution even though the brix method is the official U.S.D.A. standard method of determination. The refractometer was used because it is more accurate than the brix spindles. Figure 6 shows the Abbe-type refractometer.

pH. The Beckman pH meter was used to determine the acidity of the various products (Figure 6).

Color. The Hunter color and color difference meter (Figure 7), was utilized to ascertain any difference in color due to the influence of the several sweeteners and concentrations. This instrument has three photocells which are so filtered as to measure lightness = L, redness = a_L, and yellowness = b_L.

Two standard color plates were used to adjust the instrument as closely as possible for determination of fruit color. These standards are baked enameled plates that are prepared by the National Canners Association to resemble the color of the fruits to be tested. The standard white with readings of $L = 92.7$, $a_L = -0.6$, and $b_L = +1.2$, was adapted for the cherries because the red standard was not available. The readings of the yellow standard used for the apricots and peaches were $L = 54$, $a_L = 1$, and $b_L = 32$.

Figure 6. Abbe-type refractometer with constant temperature bath at left
Beckman pH meter at right

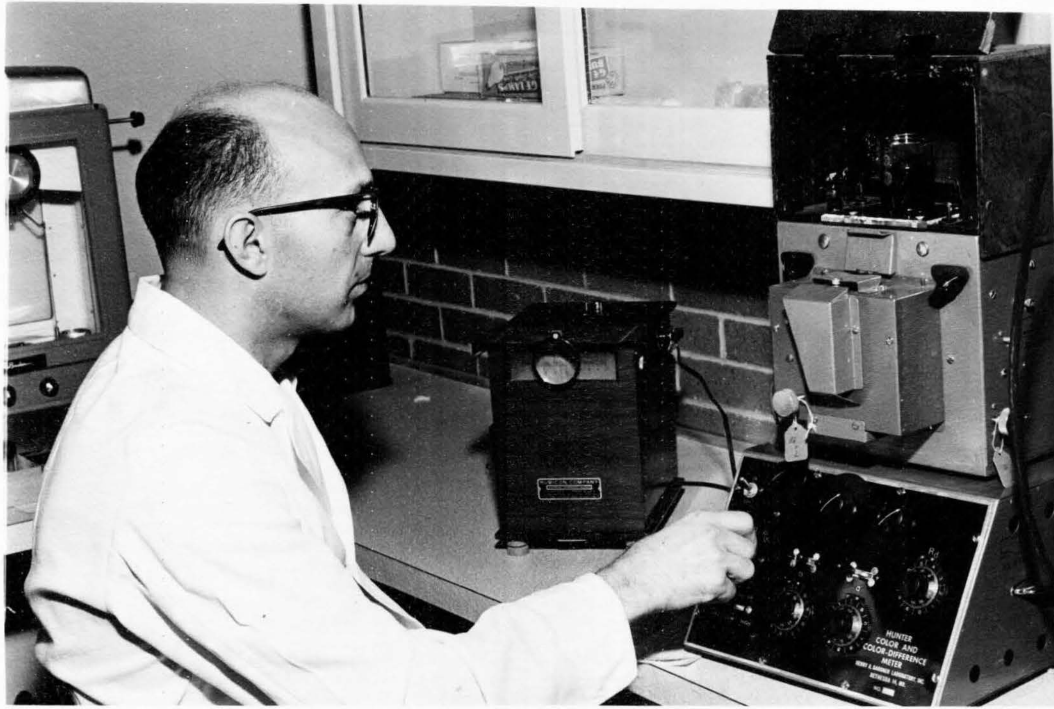


Figure 7. Hunter Color and Color Difference Meter with galvanometer at left

RESULTS

Preliminary Study (1959-60)

The results of the preliminary work are tabulated in the appendix. Table 1 contains the average taste perception values for two panels, a trained panel and a student panel. The results show that the student panel did not distinguish the differences between solutions as well as the trained panel, probably because they were told that the solutions were bitter (30).

Flavor

In general the 40 per cent sucrose solution was the most acceptable concentration for the processed fruits except the Windsor cherry and the Large Early Montgamet apricot, for these two the 60 per cent sucrose solution was best. The fruits canned in the cyclamate solutions were scaled just on the acceptable side of a 10 point rating scale. Fruits canned in the saccharin and hexamic acid solutions were so extremely bitter that they were chosen above the "like slightly" only twice. The cherries canned in hexamic acid were sampled, then discontinued as the solutions had a sour rather than a sweet taste.

Texture

The sucrose solutions influenced the texture of the cherries more than any other fruit by firming the skin especially in the higher concentration. Sucrose had very little effect on the texture of the other fruits. The saccharin solutions softened the texture just beneath the skin on the cherries.

The hexamic acid cracked and disintegrated the skin of the cherries and the flesh was soft and mushy. Its effect on the apricots was to break down the cell structure except for the fiberous tissues.

Color

The color of pears was effected by the solutions. As the amount of sucrose decreased from 325 to 0 ml and the synthetic sweetener increased inversely the pears became whiter in color. Hexamic acid caused the color of the cherries to remain a deep red on the dark sweet cherries and a bright pink for the Napoleon.

pH

The pH was constant within a given fruit but it varied slightly between fruits and varieties.

Soluble solids

The per cent soluble solids remained constant for a given fruit processed in the synthetic sweetener solutions, but with sucrose it increased proportionately to the concentration of the solution added.

Drained weight

The drained weight of all fruits had a definite trend only in those canned in the sucrose solutions. The cherries canned in the 40 per cent sucrose solution had the highest drained weight and declined to the 60 per cent solution. The apricots were exactly opposite with the 60 per cent sucrose solution being the highest and declining to the 40 per cent solution. The peaches were highest with the 50 per cent sucrose solution and decreased at the 60 and 40 per cent levels. The drained weight for the fruit in synthetic sweeteners varied from solution to solution and concentration to concentration.

Second Year Study (1960-61)

Results are divided into three sub-parts: consumer panel results, trained laboratory panel results, and objective tests.

Figure 8 is a comparison between the two panels and how the per cent acceptance of the consumer panel correlates with the quality acceptance score of the laboratory panel.

Consumer panel results

Sweet cherries. Figure 9 shows the per cent of judges that accepted Bing cherries processed by canning in the various sweeteners and their concentrations. The cherries canned in the 60 and 50 per cent sucrose solution were accepted by only one-third and three-fourths of the panel, perhaps due to the shriveling and sweetness of the cherries. Those cherries processed in 40 per cent solution were accepted by 96 per cent of the judges. The two concentrations of synthetic sweeteners, 0.15 per cent cyclamate and 0.05 per cent saccharin, were both accepted by 88 and 78 per cent of the judges respectively. When the two solutions of sucrose plus synthetic sweeteners at 10 per cent sucrose and 0.1 per cent cyclamate or 0.02 per cent

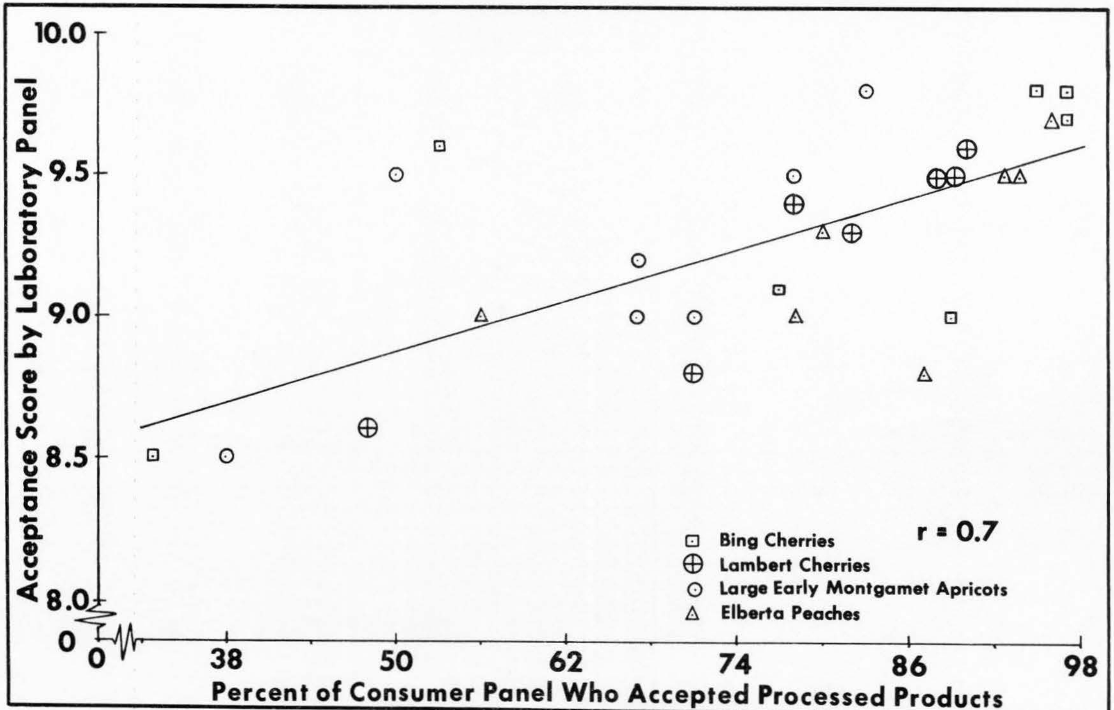


Figure 8. A comparison between 10 laboratory panelists and 117 consumer panelists in the evaluation of the quality and acceptance of Bing, Lambert cherries, Large Early Montgamet (chinese) apricots and Elberta peaches processed in several sweeteners and their concentrations

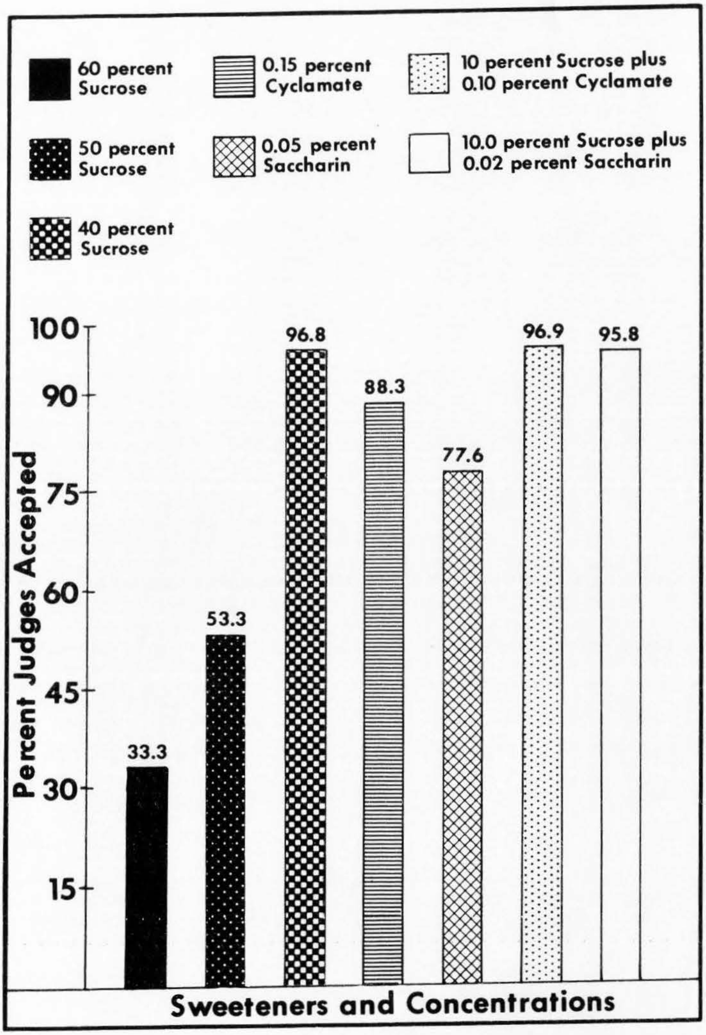


Figure 9. Acceptance of Bing cherries processed in several sweeteners and their concentrations by a consumer panel consisting of 117 judges

saccharin were used, the acceptance by the consumer panel was above 95 per cent.

The results of the Lambert cherries are contained in Figure 10. The same pattern is followed here as for the Bing cherries, but 10 per cent lower in acceptance.

The Lambert cherries processed in the sucrose solutions were accepted by a larger per cent of the judges than were the Bing cherries because the shrivelled effect was not so intense. Again the panel scored over 90 per cent for the standard 40 per cent solution. The two synthetic sweeteners were still high, but rated lower than the Bing cherries had been. The products canned in the combination solutions were accepted by almost 90 per cent.

Apricots. This product was not well liked by the panel as a whole, although only two solutions, 60 per cent sucrose and 0.05 per cent saccharin, were rejected by half of them, as is shown in Figure 11. Two sucrose concentrations, 50 and 40 per cent, were judged acceptable by approximately four-fifths of the panel. The other three solutions; 0.15 per cent cyclamate, 10 per cent sucrose plus cyclamate or saccharin, each received the approval of two-thirds of the panel.

Peaches. Figure 12 illustrates that peaches processed in the sweeteners were well accepted with the exception of those processed in saccharin, and the sucrose plus saccharin solutions; however, these were still accepted by over half the panel. Both the cyclamate, and sucrose plus cyclamate solutions averaged 90 per cent. The three sucrose

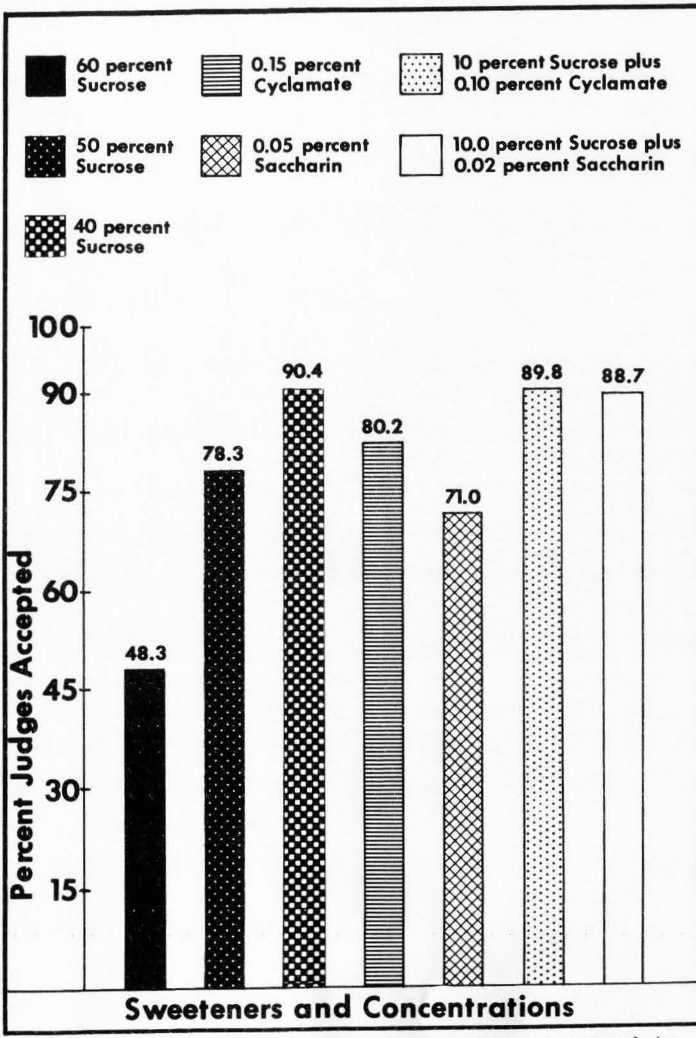


Figure 10. Acceptance of Lambert cherries processed in several sweeteners and their concentrations by a consumer panel consisting of 117 judges

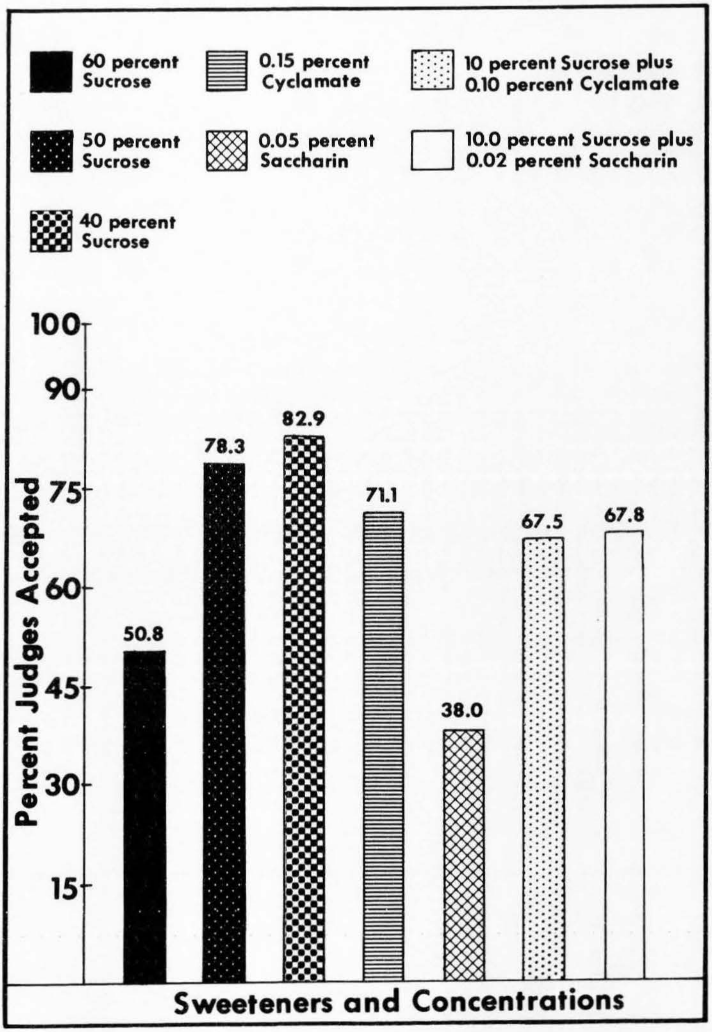


Figure 11. Acceptance of Large Early Montgamet (Chinese) apricots processed in several sweeteners and their concentrations by a consumer panel consisting of 117 judges

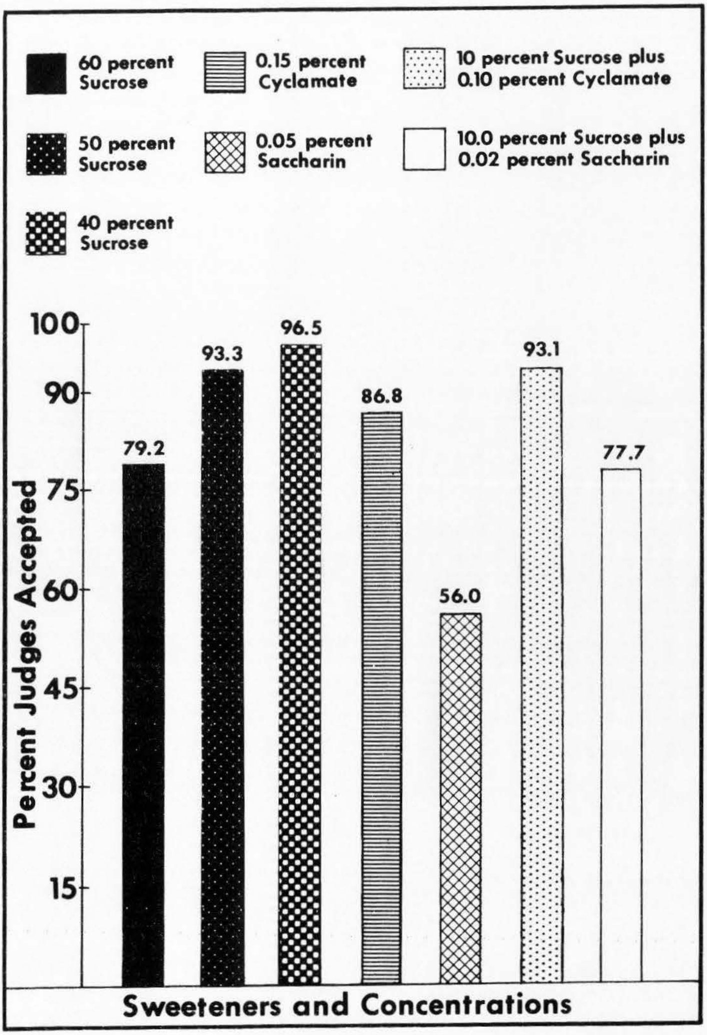


Figure 12. Acceptance of Elberta peaches processed in several sweeteners and their concentrations by a consumer panel consisting of 117 judges

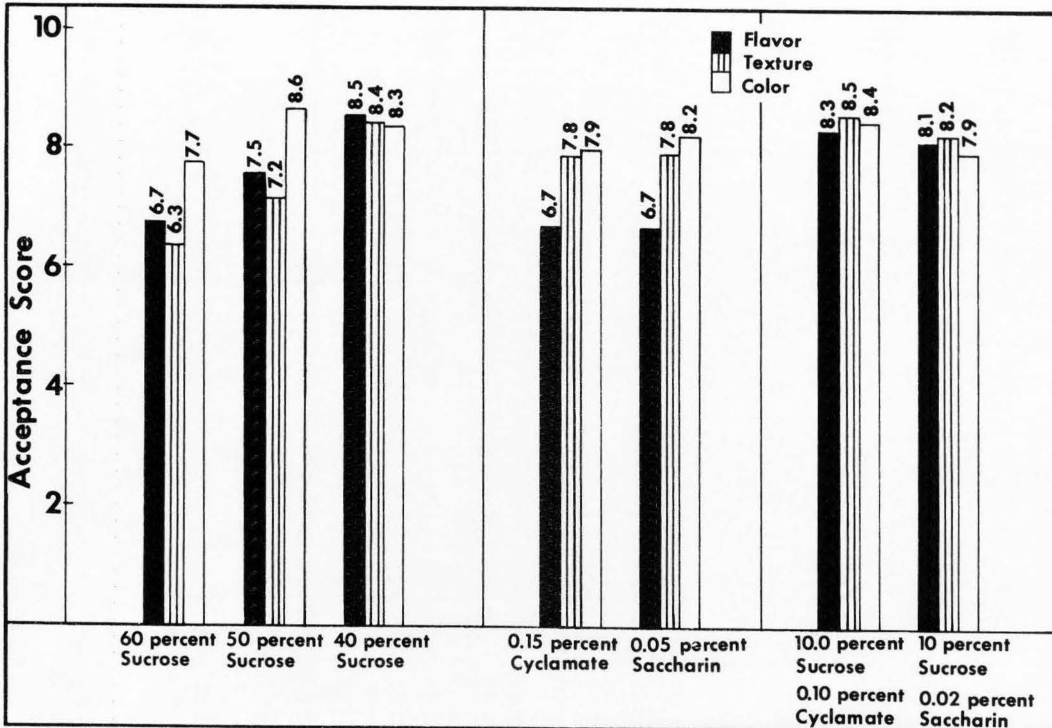
concentrations, 60, 50, and 40 per cent rated 79, 93, and 96 per cent respectively.

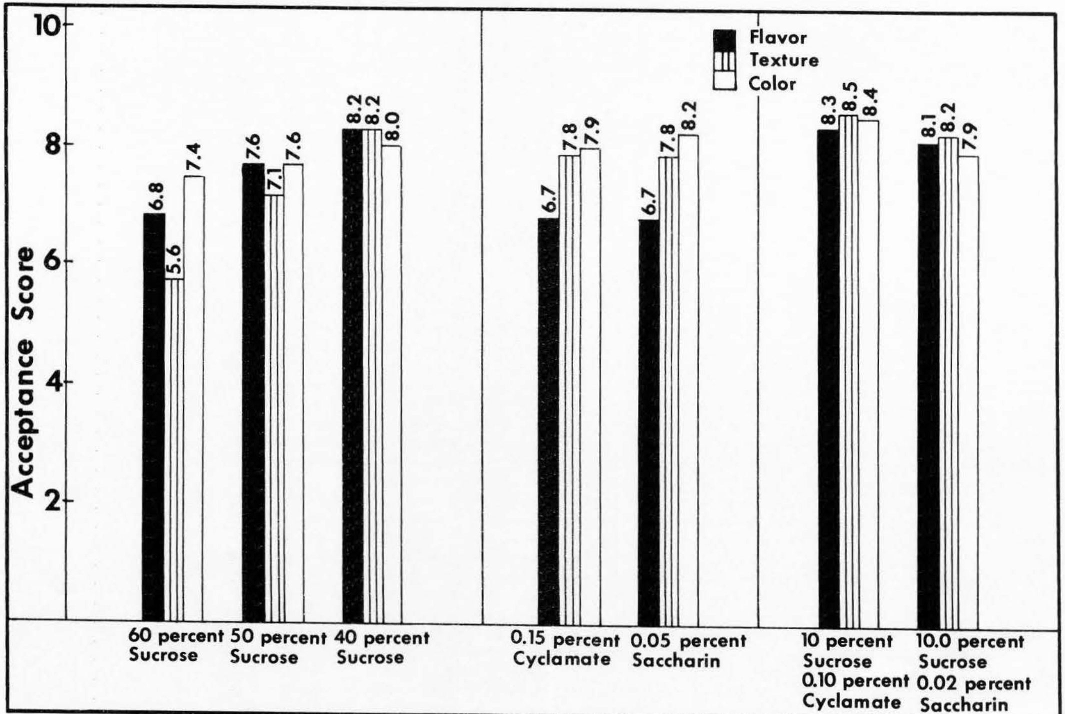
Laboratory panel results

The consumer panel was asked to accept or reject the fruit on the basis of over-all appeal; hence the per cent acceptance. The laboratory panel members scored each characteristic separately; that is, flavor, color, and texture, with values from 1 to 10. A rating of 1 was exceptionally poor, and 10 exceptionally good.

Sweet cherries. Figure 13 shows that the Bing cherries processed in the 40 per cent sucrose solution were rated highest, both for flavor and texture, and those cherries processed in the saccharin solution were lowest. However, an analysis of variance (38) was calculated for flavor, texture, and color, and no significant difference was found between the cherries processed in the different solutions. These findings substantiate the hypothesis that cherries processed in combination sweeteners and synthetic sweeteners could be as well accepted as those processed in standard sucrose solutions.

The Lambert cherries as is illustrated in Figure 14 were accepted in the same order, but not rated as high as the Bing cherries. The texture and color also followed the same pattern as for the Bing cherries, but slightly lower. An analysis of variance was calculated for each flavor, texture, and color and there was no significant difference found.


Acceptance Score
10
8
6
4
2
Flavor
Texture
Color
6.7
6.3
7.7
7.5
7.2
8.6
8.5
8.4
8.3
6.7
7.8
7.9
6.7
7.8
8.2
8.3
8.5
8.4
8.1
8.2
7.9
60 percent Sucrose
50 percent Sucrose
40 percent Sucrose
0.15 percent Cyclamate
0.05 percent Saccharin
10.0 percent Sucrose 0.10 percent Cyclamate
10 percent Sucrose 0.02 percent Saccharin

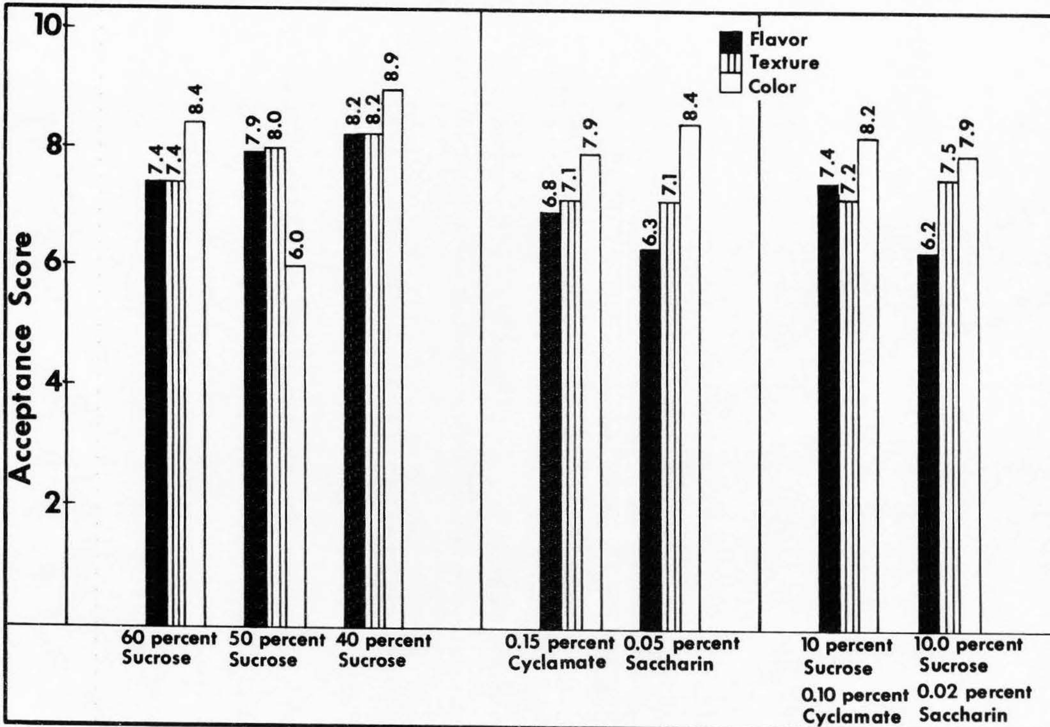

Acceptance Score
10
8
6
4
2
Flavor
Texture
Color
6.8
5.6
7.4
7.6
7.1
7.6
8.2
8.2
8.0
6.7
7.8
7.9
6.7
7.8
8.2
8.3
8.5
8.4
8.1
8.2
7.9
60 percent Sucrose
50 percent Sucrose
40 percent Sucrose
0.15 percent Cyclamate
0.05 percent Saccharin
10 percent Sucrose 0.10 percent Cyclamate
10.0 percent Sucrose 0.02 percent Saccharin

Apricots. Apricots processed in the three sucrose solutions were rated higher than any of the other four, with the 40 per cent sucrose being the highest (Figure 15). The 0.10 per cent cyclamate plus 10.0 per cent sucrose solution was rated as well as the 60 per cent sucrose solution. When 0.15 cyclamate was used as the only sweetener it was rated as "liked moderately" whereas the apricots processed in the saccharinated solutions were rated as "liked slightly."

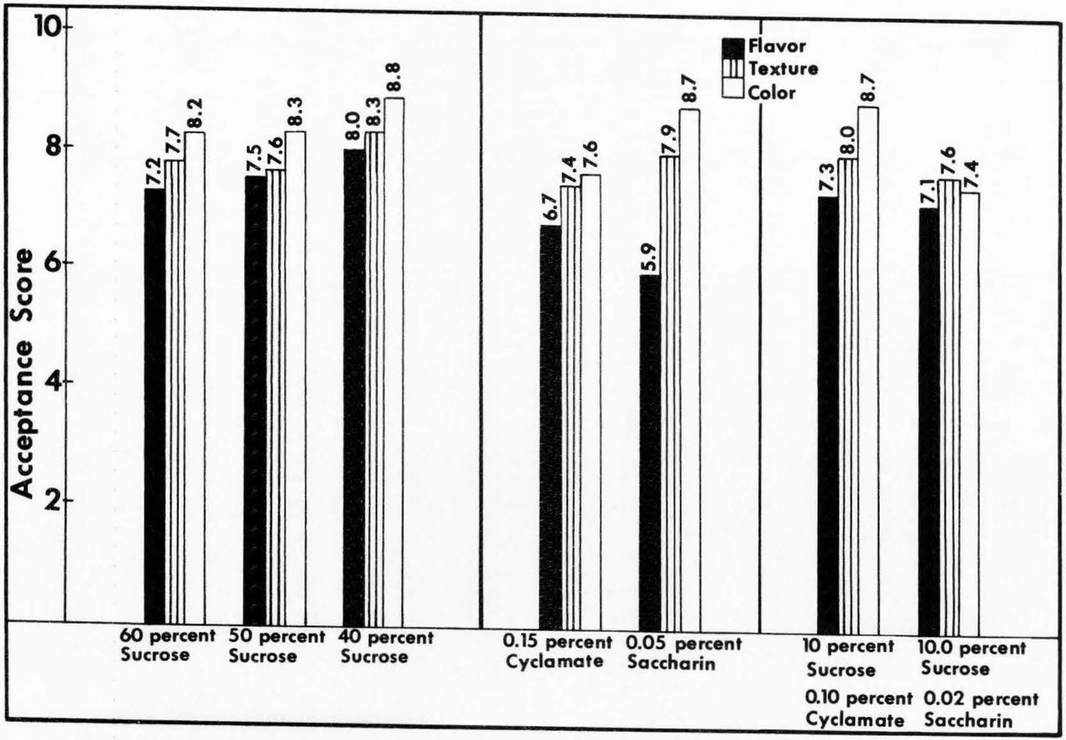
The texture of the apricot is a large factor in the acceptance or rejection of this product. If the texture is stringy and fibrous the acceptance rating is lower in spite of the excellent flavor that may exist. This is evident inasmuch as the flavor and texture ratings are so closely correlated, except in the instances where either saccharin solutions were used as the sweetening agent and this may be due to apricots not masking the bitterness of the saccharin.

The color of the apricots was rated high on all but one sample, 50 per cent sucrose. Analysis of variance was calculated for flavor, texture and color ratings and there was no significant difference between solutions within each of the above mentioned factors.

Peaches. Figure 16 depicts as with all the other fruits the peaches in the 40 per cent sucrose solution were preferred. The 50 per cent sucrose solution peaches was rated next with the combination solution of sucrose



Flavor
Texture
Color
Acceptance Score
10
8
6
4
2
7.4
7.4
8.4
7.9
8.0
6.0
8.2
8.2
8.9
6.8
7.1
7.9
6.3
7.1
8.4
7.4
7.2
8.2
6.2
7.5
7.9
60 percent Sucrose
50 percent Sucrose
40 percent Sucrose
0.15 percent Cyclamate
0.05 percent Saccharin
10 percent Sucrose 0.10 percent Cyclamate
10.0 percent Sucrose 0.02 percent Saccharin


Acceptance Score
10
8
6
4
2
Flavor
Texture
Color
7.2
7.7
8.2
7.5
7.6
8.3
8.0
8.3
8.8
6.7
7.4
7.6
5.9
7.9
8.7
7.3
8.0
8.7
7.1
7.6
7.4
60 percent Sucrose
50 percent Sucrose
40 percent Sucrose
0.15 percent Cyclamate
0.05 percent Saccharin
10 percent Sucrose 0.10 percent Cyclamate
10.0 percent Sucrose 0.02 percent Saccharin

plus cyclamate, 60 per cent sucrose, and sucrose plus saccharin being rated in descending order. The cyclamate was preferred to saccharin when these synthetic sweeteners were the only sweetening agents used. As was stated in the consumer panel results the saccharin was much more discernible when used in the Elberta peaches than any other fruit, the same holds true for the laboratory panel.

The texture and flavor relationship is again apparent here as it was for the apricots, with the saccharinated solution showing a distinct difference between these ratings.

The color of these peaches was rated high. The analysis of variance study demonstrated no significant difference for each factor.

Objective tests

Drained weight. The cherries processed in these several sweeteners illustrates very well the laws of osmosis and diffusion. The heavy syrups, such as 60 and 50 per cent sucrose solutions, showed a definite loss of weight by the fruit shrivelling and weight of the fruit. The weight of the cherries in the synthetic sweeteners was higher than the 40 per cent sucrose because of the water being absorbed into the fruit and very little being released into the remaining solution.

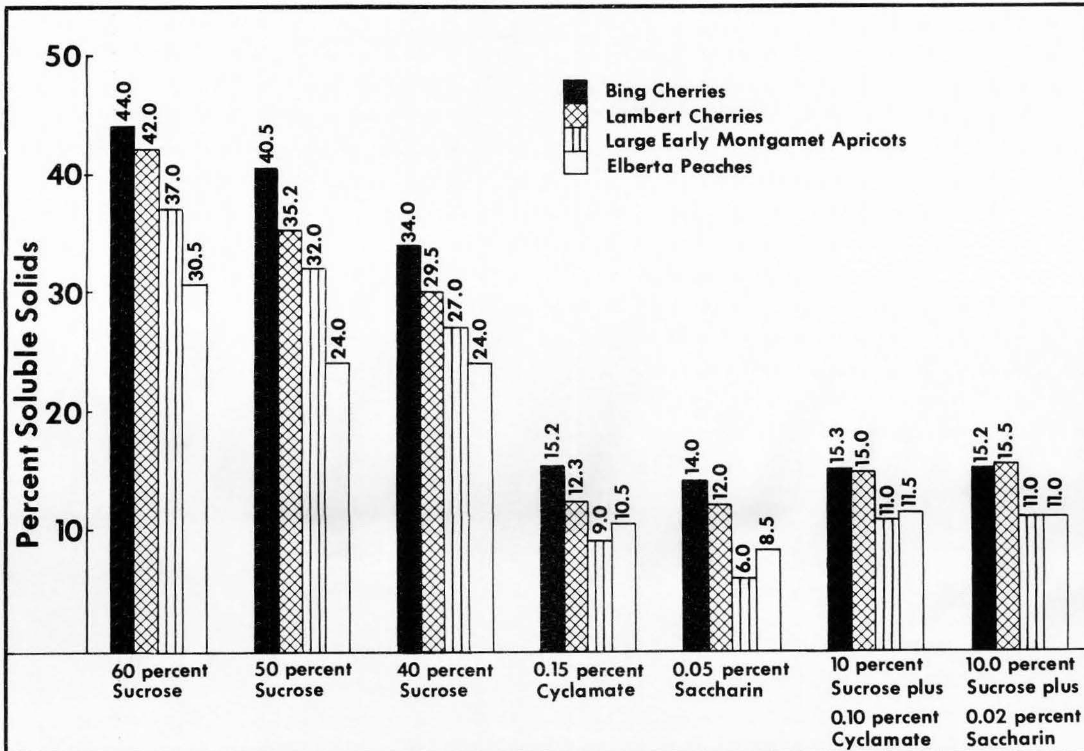
The highest drained weight was obtained in the combination sweeteners due to the absorption of water without loss of soluble solids to the solution because the sugar content of the surrounding solution was almost as high as the soluble solids in the fruit itself.

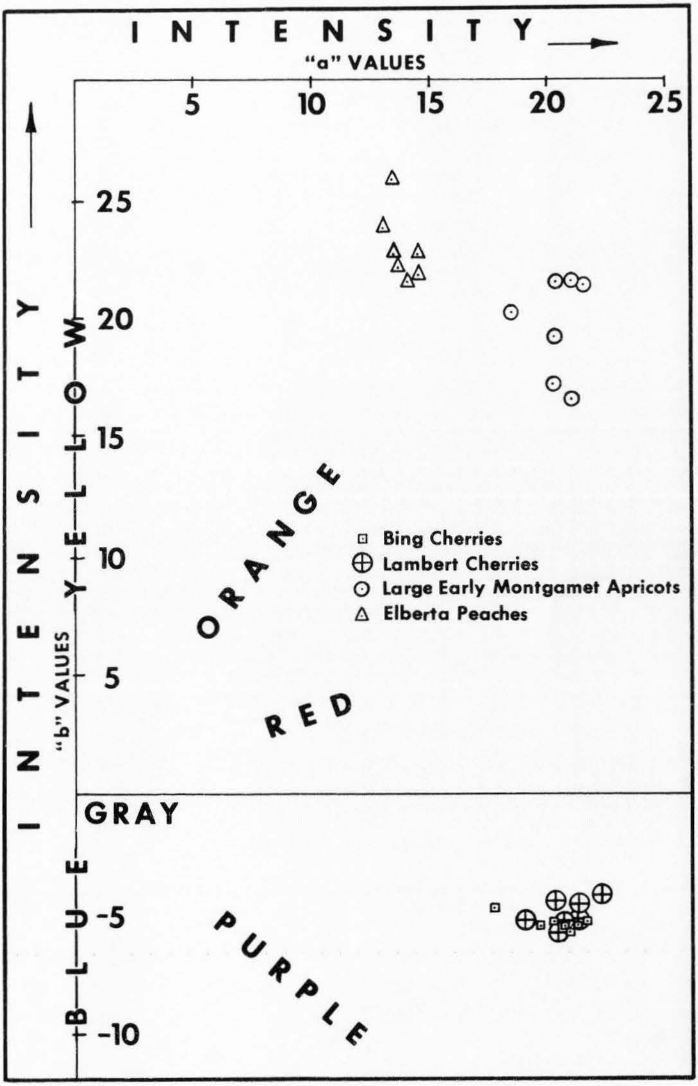
The drained weights of the apricots and peaches were different than those of the cherries because the apricots and peaches were halved and the peaches were peeled, thus the soluble solids was more readily absorbed and the weights varied with the proportions of soluble solids added in the cover syrup.

Soluble solids. Figure 17 portrays that the soluble solids content varies with type of cover solution added. The solids content of those fruits processed in synthetic sweeteners was reduced proportional to the amount of cover solution added. The solids content of those fruits processed in the 10.0 per cent sucrose and the 0.10 per cent cyclamate or 0.02 per cent saccharin remained at approximately the same level as the fruit itself. Whereas the fruits processed in the sucrose solutions were raised proportionally to the sucrose added.

pH. The difference in pH for a particular fruit processed in the different sweeteners was slight and could be due to the ripeness level of the fruit in the can.

Color. A Hunter Color and Color-difference meter was employed to determine if the sweetening agent used on a particular fruit brought about any marked change in the product as compared to the 40 per cent sucrose solution. Figure 18 illustrates the locations of the various fruits as related to its chromaticity. There was no apparent changes in color due to any particular sweetening agent used.


Percent Soluble Solids
50
40
30
20
10
Bing Cherries
Lambert Cherries
Large Early Montgamet Apricots
Elberta Peaches
44.0
42.0
37.0
30.5
40.5
35.2
32.0
24.0
34.0
29.5
27.0
24.0
15.2
12.3
9.0
10.5
14.0
12.0
6.0
8.5
15.3
15.0
11.0
11.5
15.2
15.5
11.0
11.0
60 percent Sucrose
50 percent Sucrose
40 percent Sucrose
0.15 percent Cyclamate
0.05 percent Saccharin
10 percent Sucrose plus 0.10 percent Cyclamate
10.0 percent Sucrose plus 0.02 percent Saccharin


INTENSITY
"a" VALUES
5
10
15
20
25
INTENSITY
"b" VALUES
YELLOW
BLUE
25
20
15
10
5
-5
-10
ORANGE
RED
GRAY
PURPLE
Bing Cherries
Lambert Cherries
Large Early Montgamet Apricots
Elberta Peaches

DISCUSSION

During the preliminary study it was found that hexamic acid had a bearing on retention of red color in cherries. Since the Food and Drug Administration had not approved the use of hexamic acid, its use was discontinued.

After the results of the preliminary study, it was determined that the products could be improved by combining sucrose and synthetic sweeteners in proportions that would not increase the available carbohydrate level beyond that of the fresh product. The consumer and laboratory panels' results show that those products that were processed in the combination sweeteners 10 per cent sucrose plus 0.1 per cent calcium cyclamate, and 10 per cent sucrose and 0.2 per cent sodium saccharin were as well liked as those processed in 40 per cent sucrose. Also the comments made to the author and those written on the ballots were indicative of preference to the combination sweeteners because they were more like the fresh product flavor, and not as cloying.

A commercial packer would be especially interested in the combination sweeteners because he must meet a minimum drained weight requirement. The drained weight of the fruit processed in the combination sweeteners was higher than the fill weight, but this was not so with the fruit packed in the sucrose solutions except for peaches which had a higher drained weight than fill weight.

To determine the calories available in these processed products calculations were made using reference material from Bowes and Church (9). It was found that those fruits processed with synthetic sweeteners and the combination synthetic sweeteners plus sucrose are as follows:

Calorie values of fruit processed in sweeteners per $2\frac{1}{2}$ can.

Sweeteners	Cherries	Apricots	Peaches
40 per cent sucrose	870	833	785
10 per cent sucrose plus 0.1 per cent calcium cyclamate	436	399	351
10 per cent sucrose plus 0.2 per cent sodium saccharin	436	399	351
0.15 per cent calcium cyclamate	274	255	207
0.05 per cent sodium saccharin	274	255	207

To determine the difference in cost of producing the different cover syrups, calculations were made on a case lot of 24 size $2\frac{1}{2}$ cans. According to wholesale price of sucrose, calcium cyclamate and sodium saccharin, the wholesale price of the latter two were furnished by Beck (5) and Hoffman (14).

Concentration	Sweetening agent	Price per case
40 per cent	Sucrose	\$0.80
10 per cent 0.1 per cent	Sucrose plus calcium cyclamate	\$0.234
10 per cent 0.02 per cent	Sucrose plus sodium saccharin	\$0.202
0.15 per cent	Calcium cyclamate	\$0.058
0.05 per cent	Sodium saccharin	\$0.015

SUMMARY

The purpose of this investigation was to provide a new product or products by sweetening fruits with calcium cyclamate, sodium saccharin, sucrose, and combinations of sucrose plus calcium cyclamate, and sucrose plus sodium saccharin.

Studies were conducted to evaluate effects of sweeteners and their various concentrations on fruits and quality evaluations.

Preliminary studies conducted in 1959-60 led to the selection of the concentrations of solutions used in the 1960-61 project. It can be stated in general that the fruits processed in the 40 per cent sucrose solution was the most acceptable. As the concentration increased to the 60 per cent sucrose, the acceptability of the fruits decreased. The exception to the general statement was: the Bing cherries processed in the 10 per cent sucrose plus 0.1 per cent calcium cyclamate was rated higher than the 40 per cent sucrose.

The combination sweeteners, 10 per cent sucrose plus 0.1 per cent calcium cyclamate, and 10 per cent sucrose plus 0.02 per cent saccharin were almost as well excepted as was the 40 per cent sucrose solution on all fruits used in this experiment except apricots. Many persons who were on the panels stated that they did not particularly

like apricots which could account for their over-all lower rating.

The products processed in calcium cyclamate were preferred to those sweetened with sodium saccharin when these agents were used as the sole sweeteners.

The apparent order of preference for the cover solutions on the products were: 40 per cent sucrose, 10 per cent sucrose plus 0.1 per cent calcium cyclamate, 10 per cent sucrose plus 0.02 per cent sodium saccharin, 0.15 per cent calcium cyclamate, 50 per cent sucrose, 0.05 per cent sodium saccharin, and 60 per cent sucrose, but an analysis of variance was calculated on the results of the laboratory panel and no significant difference was found at the 5 per cent level between the flavor, texture and color of all products processed in the above sweeteners.

The drained weights were highest when the products were processed in the two combinations of sweeteners, and those processed in the sucrose solutions were lowest except on the peaches.

The soluble solids varied proportionately to the concentration of the sucrose added.

The pH and the color difference values remained constant throughout the different concentrations.

A comparison of the commercial pack of 40 per cent sucrose with the most acceptable of the experimental dietetic packs of 10 per cent sucrose plus 0.1 per cent cyclamate or 0.02 per cent saccharin for one case of No. 2½ cans cost \$.80, \$.22, and \$.20 respectively.

Calorie evaluations indicate that fruit products processed in 40 per cent sucrose contained twice the calorie value as fruit processed with 10 per cent sucrose plus 0.1 per cent cyclamate, and three times the value of fruit sweetened only with cyclamate.

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APPENDIX

Table 1. Effect of sweeteners and their concentrations on the taste perception[2] as judged by 10 trained panelists and 15 untrained students

Panel	Sodium saccharin (percent)			Calcium cyclamate (percent)			Hexamic acid (percent)			Sucrose (percent)		
	1.0	1.25	1.5	1.0	1.25	1.5	1.0	1.25	1.5	40.0	50.0	60.0
Trained	1.9	2.5	1.4	4.6	4.3	3.0	2.8	3.6	1.6	8.1	7.7	8.5
Student	4.1	2.0	2.3	4.3	3.4	3.2	4.3	4.3	1.2	5.0	4.7	4.5

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 2. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weight of processed Bing cherries

Sweetener	Concentration %	Quality acceptance scores[a] Flavor	Texture	Color	Soluble solids %	pH	Drained weight (grams)	Remarks
Sodium saccharin	1.00	2.3	5.0	7.3	11.5	4.0	324	Sour, bitter
	1.25	2.6	6.2	7.7	11.5	4.2	319	Bitter
	1.50	2.0	5.5	7.9	12.5	4.1	332	Sour
Calcium cyclamate	1.00	7.9	7.8	8.0	12.0	4.0	320	Very good, tough
	1.25	6.9	7.0	7.7	12.5	4.0	311	Rather sweet
	1.50	5.5	5.8	8.0	12.0	3.8	325	Little tough
Hexamic acid	1.00	4.0	2.2	6.2	12.5	2.9	321	Mushy, soft
	1.25	5.3	3.5	5.7	13.8	3.4	327	Mushy, too strong
	1.50	4.5	2.5	5.6	12.5	2.9	296	Too soft, mushy
Sucrose	40.0	7.7	6.1	7.9	26.8	4.2	339	Mushy
	50.0	6.7	6.6	7.8	31.2	3.9	330	Too sweet
	60.0	7.2	6.7	7.9	33.0	4.1	323	Too sweet

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 3. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weight of processed Lambert cherries

Sweetener	Concentration %	Quality acceptance scores[a]			Soluble solids %	pH	Drained weight (grams)	Remarks
Sodium saccharin	1.00	2.5	6.9	8.7	10.2	4.0	405	Sour
	1.25	2.8	7.1	8.4	10.5	4.0	404	Bitter
	1.50	2.3	6.8	7.7	11.0	4.0	412	Bitter
Calcium cyclamate	1.00	7.7	8.2	8.9	10.2	3.7	389	Good, slightly tough
	1.25	6.3	7.6	8.3	10.8	3.8	391	Good texture
	1.50	6.6	8.3	9.0	10.5	3.8	390	Poor flavor
Hexamic acid	1.00	4.5	2.7	6.2	10.5	3.0	400	Too soft
	1.25	4.8	4.3	7.4	10.5	3.1	404	Sour and soft
	1.50	3.9	3.0	7.1	10.6	3.1	394	Mushy
Sucrose	40.0	7.3	8.4	8.0	24.0	4.1	409	Too sweet
	50.0	8.9	8.7	9.6	27.8	4.0	399	Firm, very good
	60.0	8.9	8.1	8.5	30.5	4.0	392	Sweet

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 4. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weight of processed Napoleon cherries

Sweetener	Concentration %	Quality acceptance scores[a]			Soluble solids %	pH	Drained weight (grams)	Remarks
		Flavor	Texture	Color				
Sodium saccharin	1.00	3.4	4.8	8.3	10.8	3.1	376	Sour, strong
	1.25	2.5	4.3	8.3	11.5	3.6	376	Sour
	1.50	2.1	5.4	8.0	11.5	3.9	377	Bitter
Calcium cyclamate	1.00	6.5	6.9	7.0	10.8	3.7	373	Good
	1.25	5.8	6.9	7.6	11.2	3.7	379	Little strong
	1.50	6.3	6.3	8.0	10.7	3.8	374	Good flavor
Hexamic acid	1.00	4.5	2.4	5.2	11.0	2.9	375	Cracked, mushy
	1.25	4.9	3.1	5.1	10.8	3.0	380	Sour and soft
	1.50	4.5	3.1	6.3	11.5	2.9	384	Mushy, strong
Sucrose	40.0	8.3	6.9	7.7	24.5	3.8	382	Sweet
	50.0	7.9	6.9	5.9	28.5	3.8	378	Too sweet
	60.0	7.5	6.4	8.6	30.0	3.8	372	Too sweet

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 5. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weights of processed Windsor cherries

Sweetener	Concentration %	Quality acceptance scores[a]			Soluble solids %	pH	Drained weight (grams)	Remarks
		Flavor	Texture	Color				
Sodium saccharin	1.00	2.3	5.5	5.5	9.2	4.1	418	Sour
	1.25	2.2	5.5	4.7	9.5	4.1	426	Sour
	1.50	2.3	4.7	4.2	9.3	4.0	418	Unpleasant
Calcium cyclamate	1.00	7.0	7.1	7.2	9.0	4.1	4.8	Sweet
	1.25	5.5	6.7	6.2	9.8	4.1	413	Too strong
	1.50	6.5	6.7	4.6	9.2	3.8	410	Too sweet
Hexamic acid	1.00	3.9	2.8	6.7	8.8	3.0	388	Sour and soft
	1.25	5.5	3.5	6.6	9.2	3.5	394	Mushy, bitter
	1.50	5.0	3.7	6.9	9.0	3.2	387	Mushy
Sucrose	40.0	7.1	7.2	5.5	23.7	4.0	408	Good
	50.0	7.0	7.1	5.8	26.5	4.0	395	Too sweet
	60.0	8.0	7.3	6.5	29.2	4.0	393	Too sweet

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 6. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weight of processed Large Early Montgamet (Chinese) apricots

Sweetener	Concentration %	Quality acceptance scores[a] Flavor	Texture	Color	Soluble solids %	pH	Drained weight (grams)	Remarks
Sodium saccharin	1.00	2.1	3.4	7.4	7.8	3.8	341	Poor, sour
	1.25	2.6	3.3	6.7	7.7	3.7	340	Bitter, stringy
	1.50	1.7	3.5	6.3	7.7	3.7	346	Soft
Calcium cyclamate	1.00	7.1	5.9	7.2	7.40	3.6	370	Good, stringy
	1.25	7.5	5.1	7.1	7.2	3.6	365	Course, stringy
	1.50	5.6	5.3	7.2	7.2	3.8	375	Mushy, stringy
Sucrose	40.0	8.0	5.9	7.5	19.5	3.7	378	Mushy, stringy
	50.0	7.3	5.0	8.0	22.2	3.6	374	Quite good
	60.0	8.3	6.5	8.5	25.0	3.7	378	Too sweet

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 7. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weight of processed Moorpark apricots

Sweetener	Concentration %	Quality acceptance scores[a] Flavor	Texture	Color	Soluble solids %	pH	Drained weight (grams)	Remarks
Sodium saccharin	1.00	3.2	4.8	8.3	6.5	3.8	399	Bitter, stringy
	1.25	1.4	4.0	4.5	6.5	3.8	392	Bitter
	1.50	2.1	3.7	4.5	7.2	3.9	392	Strong, bitter
Calcium cyclamate	1.00	6.2	5.5	8.9	7.2	3.8	422	Soft, mushy
	1.25	5.0	3.5	7.2	6.4	3.7	399	Soft, bitter
	1.50	4.4	3.7	7.2	7.0	3.7	416	Sour, soft
Sucrose	40.0	6.6	4.9	8.3	17.8	3.7	421	Mushy
	50.0	6.5	5.7	8.2	20.7	3.7	436	Mushy
	60.0	5.8	4.5	7.6	22.7	3.8	436	Bitter

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 8. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weight of processed Red Haven peaches

Sweetener	Concentration %	Quality acceptance scores[a] Flavor	Texture	Color	Soluble solids %	pH	Drained weight (grams)	Remarks
Sodium saccharin	1.00	2.2	7.1	7.5	8.2	3.8	563	Bitter, sour
	1.25	2.0	6.1	7.7	9.0	3.8	554	Sour, too sweet
	1.50	2.2	6.9	7.4	8.2	3.8	535	Bitter
Calcium cyclamate	1.00	6.6	7.8	8.5	8.5	3.8	558	Too strong
	1.25	6.0	7.3	8.0	8.5	3.9	547	Off flavor
	1.50	5.3	7.4	7.5	8.5	3.7	554	Too strong, too sweet
Sucrose	40.0	8.4	8.1	8.5	21.6	3.8	541	Good, little sweet
	50.0	7.9	8.0	8.3	22.5	4.0	558	Very good pretty good
	60.0	7.0	7.9	8.5	28.0	4.0	534	Too sweet

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 9. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weight of processed Elberta peaches

Sweetener	Concentration %	Quality acceptance scores[a] Flavor	Texture	Color	Soluble solids %	pH	Drained weight (grams)	Remarks
Sodium saccharin	0.15	6.2	5.3	7.8	9.5	4.1	473	Off flavor
	0.20	4.0	4.8	5.7	8.5	3.9	473	Sweet
	0.30	3.8	5.1	6.7	8.0	4.0	457	Sour, bitter
Calcium cyclamate	0.15	6.9	5.4	8.4	9.5	4.0	507	Sweet
	0.20	4.9	6.4	7.4	9.0	4.0	490	Little sour
	0.30	7.1	7.0	8.2	9.5	4.1	517	Lacks flavor
Calcium cyclamate + Sodium saccharin	0.135 + 0.015	6.3	5.2	5.6	7.5	4.0	421	Soft, stringy
	0.18 + 0.02	5.7	5.3	6.6	7.5	4.0	442	Stringy
	0.27 + 0.03	6.6	5.1	6.4	7.5	4.1	436	Stringy, lacks flavor
Sucrose	40.0	8.2	6.9	8.3	21.5	3.8	503	Good flavor, soft
	50.0	8.3	7.0	9.0	26.0	4.0	443	Good, too sweet
	60.0	7.9	7.0	8.6	27.7	4.0	476	Too sweet

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Table 10. Effect of sweeteners and their concentrations on quality acceptance, soluble solids, pH, and drained weight of processed Bartlett pears

Sweeteners	Proportions sweetener concentrations: Sucrose 40 percent	Synthetic sweetener 1 percent	Quality acceptance scores[a]: Flavor	Texture	Color	Soluble solids (percent)	pH	Drained weight (grams)	Remarks
Calcium cyclamate + sucrose	325	0	7.5	6.3	7.4	26.7	4.3	453	Rather sweet
	240	85	7.4	5.8	8.6	21.3	4.2	494	Grainy
	162	162	7.6	6.0	8.4	16.8	4.3	455	Gritty
	85	240	7.7	5.2	7.5	12.2	4.2	465	Natural pear flavor
	0	325	6.0	6.7	6.1	8.5	4.1	462	Off flavor
Sodium saccharin + sucrose	325	0	7.4	5.7	7.9	25.5	4.1	490	Too sweet
	240	85	7.3	6.3	6.0	22.5	4.1	445	Too hard
	162	162	6.0	6.2	7.9	17.0	4.1	464	Too hard, sweet
	85	240	5.5	6.8	7.8	13.5	4.2	474	Hard
	0	325	4.0	6.4	8.4	8.5	4.2	505	Bitter, too sweet
Sucrose	325 ml. of 50% sucrose		7.4	6.6	8.0	25.6	4.2	474	Gritty
	325 ml. of 60% sucrose		7.6	6.5	8.6	29.5	4.2	493	Too sweet

[a]Scores based on 1-10 rating. 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Ballot used for the Trained Laboratory Panel

QUALITY EVALUATION BALLOT

NAME______________________________ DATE____________

SAMPLE	FLAVOR[a]	TEXTURE[a]	COLOR[a]	REMARKS
1				
2				
3				
4				
5				
6				

[a]Score on the basis of 1-10 rating; 1=extreme dislike; 5=neither like nor dislike; 10=extreme like

Instruction Sheet and Ballot Given to the Consumer Panel

NAME ______________________________

Circle one.

Like   Dislike   Neither like nor dislike

Would you buy this product if it were available?

Yes   No

Comments:

INSTRUCTIONS:
1. Serve this sample to your family in the same manner which you would ordinarily serve this product.

2. Have each member of your family over six years of age complete his individual ballot for this product. (Please include your comments: examples; too sweet, too sour, flavor good, tastes good, but I don't care for this particular product, etc.).

3. After completing each ballot, place them in the envelope provided and they will be picked up as the next sample is delivered.