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THE UTILIZATION OF FRUITS AND VEGETABLES IN THE RIO GRANDE VALLEY.*

by

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In our Laboratory we investigate the utilization of Texas fruit and vegetable crops by canning, freezing, drying, fermentation, and recovery of constituent products. We also study methods for disposing of wastes and residues which result from processing. In developing and demonstrating advantageous methods for using perishable crops, our object is to provide growers with facilities for disposing of grades unsuited for shipping, and for stabilizing markets by diversion of surpluses, compensating for seasonal fluctuations in production and demand, although not correcting the over- or under-planting of a crop.

CITRUS PRODUCTS AND CITRUS WASTE DISPOSAL:

About 600,000 tons of grapefruit are produced annually in South Texas; and approximately one-third of this crop is diverted to citrus products, chiefly canned and barrelled juice for domestic and foreign markets. The equivalent of 5,000,000 cases of twenty-four No. 2 size cans of juice and sections is packed, principally from fruit whose size, shape or external appearance renders it least desirable for fresh fruit markets. At $5.00 a ton, which should be a minimum price accepted by growers, 200,000 tons of fruit returns a gross of one million dollars annually, this being incidental to the protection of fresh fruit markets afforded by diversion of blemished fruit.

Most of the canned grapefruit juice is consumed during summer months, when fresh fruit from South Texas is not available. Therefore, the juice pack does not compete with fresh fruit, but in effect extends the grapefruit marketing period throughout the entire year. We demonstrated in this section the methods developed in laboratories of our Bureau for reaming, screening, deaerating, flash pasteurizing and rapid cooling, by means of which grapefruit juice may be canned without excessive cooked flavor or darkening and without the development of bitter or rank terpeny flavors during storage. The forty-five canneries established during the last five years have sufficient capacity to process the entire Texas grapefruit crop.

As a result of the operation of citrus processing plants in Texas, it is necessary to dispose of about 120,000 tons of solid cannery residue, consisting of peel and pulp, in addition to millions of gallons of liquid wastes, ranging from 1,000 to 80,000 parts per mil-

lion in Biochemical Oxygen Demand. Improper handling results in odor and insect nuisances.

In cooperation with the State Board of Health, members of our Laboratory have demonstrated the value of rapid yeast fermentation as a low cost, preliminary treatment for screened liquid wastes. Fermentation will convert two-thirds of the soluble solids to volatile substances, at the same time precipitating colloidal material to yield a clear effluent. The yeast sediment from this treatment may be combined with the peel for drying, and the clear effluent may be diluted with water for use in irrigation, or it may be mixed with domestic city sewage for treatment by standardized sewage treating methods.

In disposing of the solid cannery residues, an average cost of twenty-five cents a ton for hauling and burying in remote localities would represent a total expense of $30,000.00 per year. This material may be used in fresh condition for cattle feed. It may be converted to ensilage by grinding and thoroughly mixing with chopped cereal hays; and it may be ground for application to the soil as humus fertilizer. It may also be reduced by chemical treatment, or fermentation, for use as humus. Various constituent products, such as fixed and essential oils, pectin or naringin (bitter glucoside), may be recovered.

After studying humus and feed markets, fuel costs and other local conditions, members of our Laboratory who have worked upon this problem have concluded that, at present, application to groves for humus and conversion to feed by ensiling or drying are the most feasible methods for utilizing large quantities of Texas grapefruit cannery residues.

A few years ago we investigated the preparation of wines and brandies from citrus fruits, and prepared sound "Sherry" and "Sauterne" types, and other wines. The flavors differ from those of grape wines and brandy, and production costs would probably be higher. We have preserved grapefruit and orange juices by quick freezing, with excellent results. However, commercial developments in this field do not appear to be promising, except in instances where market outlets are established in advance. Marmalade, spiced pulp butters, and candied fruits have been successfully prepared from citrus and other fruits, and these products offer promise for commercial production under suitable conditions.

Future work in our Laboratory, in relation to citrus products, will include continuation of our study of low cost methods of disposing of citrus wastes, the demonstration of methods for improving the quality of canned juices, and encouragement of commercial development of grapefruit carbonated beverage bases, and blends of citrus and other juices. Blends of grapefruit juice with orange and with carrot juices have excellent flavor. The carrot blend may be seasoned with salt, celery and spice as a cocktail, or flavored with essential oil as a beverage.

SUB-TROPICAL AND DECIDUOUS FRUIT PRODUCTS:

Payaya products are a new and promising development in south Texas. A pulpy beverage is prepared by separating the peel and seeds from ripe papaya and passing the flesh through a high speed pulper and finisher to produce fine, smooth pulp. The pulp may be mixed with an equal volume of grapefruit juice, or with an equal volume of a mixture consisting of 35 percent lemon juice and 65 percent water. Sufficient sugar is added to increase the soluble solids of the finished beverage to about 18 percent. The mixture may be flash heated to 200° F. filled, sealed and inverted for ten minutes before cooling rapidly.

Lemon juice or citric acid is added to the cubed or crushed papaya for canning in syrup and for preparing preserves or ice cream sundae topping. Preliminary tests have been made on drying and grinding the papaya seed and peel residue for use in mixed feeds. As a result of experiments by members of the Texas Experiment Station and others, about 100,000 papaya plants of improved strains are now being planted, and skillful growers are able to operate profitably at present prices paid for the fruit.

Fig products have been investigated extensively by the Texas Experiment Station at Angelton, Texas. Other fruit crops grown in Texas, including dates, berries, melons, grapes, peaches and apricots, have received limited attention in our Laboratory, due to restrictions imposed by allotments and personnel. Expansion in melon and berry production in southern sections of the state makes increasing attention to these fruits desirable.

VEGETABLE PRODUCTS:

Two years ago the work of our Laboratory was expanded to include investigation of vegetable products. Twenty thousand cars of vegetables are shipped each year from the Lower Rio Grande Valley. Other important vegetable producing areas exist in the Winter Garden section, in the irrigated Rio Grande Valley above and below El Paso, and throughout Texas from Corpus Christi into Louisiana, Arkansas and Oklahoma. Approximately thirty-five vegetables are grown. The leaders in quantities produced are cabbage, potatoes, tomatoes, carrots, onions, beets, parsley, corn, spinach, beans and peas.

Producing seasons in southern vegetable sections follow those in northern areas, making it possible to adjust canned and frozen packs to market needs resulting from seasonal variations in productivity. Differences in soil and climate makes it impossible to transfer growing and packing methods developed in one section to another without modifications. Several canning ventures in this section have failed because of efforts to use varieties; cultural practice and handling methods developed elsewhere were unsuccessful under the conditions existing in the south. Varieties of tomatoes, corn and peas grown for canning elsewhere have been failures in south Texas; but cooperative tests with the Texas Experiment Station have demonstrated varieties which produce crops of excellent canning quality.

Tomato juice and catsup of excellent color and flavor can be prepared from tomatoes of suitable varieties produced in this area. We have also canned packs of fine quality lima beans, peas, earworm-resistant sweet corn and vegetable juice blends. We have dried Texas onions and carrots to yield products of satisfactory flavor and color. Vegetables and vegetable juices are commercially canned, but best adapted varieties and processing methods remain largely to be determined under controlled tests.

FREEZING PRESERVATION:

Interest in the freezing preservation of fruits and vegetables is spreading in the southwest. About 2,000 acres of peas, broccoli, string beans, lima beans, sweet corn, spinach and other vegetables are grown for freezing in the Lower Rio Grande Valley and proposed investigations of varieties and methods may reveal possibilities which have not been anticipated.

The purpose of freezing storage is ordinarily the preservation of selected foods with minimum change in flavor, appearance, and food value. Frozen foods must compete in price with other foods, but, although freezing increases distribution and storage cost, the buyer of desirable grades is assured of fancy, uniform quality without shrinkage or waste. Among the reasons for the increase in the popularity of frozen vegetables are: 1. Varieties are selected for color, flavor and texture, and not because of such consideration as shipping quality. 2. Vegetables may be grown where conditions are most favorable, harvested when at their best, and if adapted to freezing and properly blanched, frozen and stored, they may be delivered anywhere at any time in virtually the same condition as when freshly harvested. 3. While the necessity of maintaining the products at low temperatures increases distribution and storage costs, preparation for freezing includes such operations as cleaning, sorting, grading, peeling, shelling, coring, slicing, pulping, juicing, etc., so that bulk and weight are decreased and products are ready for immediate use. 4. Proper freezing methods actually shorten cooking time, with the result that after cooking the vegetables have an exceptionally fresh flavor and color, which may excell that of the best raw vegetables available in local markets.

Some restaurants now use frozen vegetables the year round, even when locally grown vegetables are in season, because the frozen vegetables are uniform in quality and cost at all seasons of the year, making it easy to calculate the cost of each portion served. No labor or shrinkage is involved in preparation, little storage space is required, and orders may be served freshly cooked within a few minutes after being received.

If one considers the uniform fancy quality of good frozen vegetables, the convenience of use, and the avoidance of waste, the cost of frozen products may be little, if any, higher than the average cost of vegetables purchased at local markets.

The bulk of the frozen vegetable pack has been distributed to the institution trade, but retail distribution is being gradually extended as grocers and consumers are equipped and educated to handle products properly.

An important factor in the further expansion of the freezing industry is the attitude of retail grocers who have installed freezing storage cabinets for dispensing frozen vegetables, fruits, meats and fish. Some grocers prefer to sell the frozen merchandise, because it is possible to determine profits in advance, and it is unnecessary to repeatedly sort and reprice fresh vegetables as quality deteriorates. Also, it is possible to sell frozen meats and fish without the expense of a butcher and butcher shop, important items to small grocers in eastern cities where labor costs are high.

The future of the frozen pack industry will be greatly affected by the quality of products. The maintenance and improvement of quality necessitates adequate attention to every stage of manufacture, storage, and distribution. Most suitable varieties must be employed. A great deal of information on varietal suitability is being made available as a result of State and Federal investigations and commercial experience. Fruits and vegetables must be harvested when at the optimum condition for freezing, which may differ from the best stage for canning, drying or shipping. Mechanical devices, including the tenderometer and penetrometer, are proving valuable for determining maturity of English peas and certain fruits, but in most instances freezers are still dependent upon the judgment of field men.

Proper handling of harvested fruit and vegetables is essential for retention of the full flavor and food value. Although some whole fruits and vegetables can be held for several days without excessive deterioration if rapidly cooled and held at temperatures below 38° F., the practice should not be followed. If the materials are held, the quality will not be satisfactory as it should be in order to make and hold customers.

Washing, grading and trimming should be adequate to the needs of the product. Separation by size or specific gravity is used for some products, and color grading is commonly employed. Inferior material must be scrupulously removed to insure the quality of packs.

Because peeling, shelling, slicing, crushing or bruising releases the enzymes and permits the penetration of spoilage organisms, blanching should follow with as little delay as possible in order to avoid damage to color, flavor, texture and keeping quality.

Vegetables are commonly scalded or blanched for one to eight minutes in steam or hot water to reduce the activity of enzymes and spoilage organisms. Insufficient blanching may be indicated by loss of flavor or color even under favorable storage conditions. Blanching is not ordinarily employed for fruit products which are protected from oxidation by syrups, or by vacuum packing.

Vegetables should be cooled as rapidly as possible after scalding to minimize the effect of heat upon the flavor. Cooling is ordinarily accomplished by immersion in large quantities of fresh, cold water. Not more than a few minutes should elapse between scalding and freezing, or the quality may be impaired.

FREEZING AND STORING:

Products may be frozen prior to packaging, or in the packages intended for distribution. In freezing prior to packaging, products may be exposed in shallow layers on belts or trays to the freezing action of some liquid or gas, cooled and circulated at low temperature. Gases used include air, carbon dioxide, and brine fog; liquids include brine and sugar syrup. Several continuous processes have been developed and are extensively applied. In some instances the freezing of small products such as English peas may be substantially completed within a few minutes. Ice cream freezers have been used for freezing juices and pulps prior to packaging.

When products are frozen in packages, rapid freezing depends upon adequate contact of packages with some medium of high heat conductance which is maintained at a suitably low temperature. Metallic plates, solid carbon dioxide, and rapidly circulated air are used as heat exchange media for freezing products in cartons, barrels, and crates. In addition, alcohol and brines are used for freezing products in sealed containers. Cans may be rotated, as in canning, to increase the rate of heat transfer as much as 400 percent.

Temperatures used for freezing range from 0° to -90° F. A temperature of about -18° F. is commonly maintained in air circulated rapidly over ammonia expansion coils, for freezing bulk products on trays or on belt conveyors prior to packaging.

Sometimes a fine spray of cold water, or weak brine, is applied to vegetables before leaving the freezing tunnel, to provide a continuous transparent glaze of ice, enhancing the appearance and providing some protection from contact with the air. Allowance for the weight of the ice should be made in declarations of the net contents of the package.

In general, the rate of freezing is more important than the temperature employed, and is important for most products. Berries, frozen with sugar in barrels in the "cold pack" process, were suitable for use by preserve and jelly manufacturers. It was only considered necessary to freeze the product with sufficient rapidity to avoid fermentation. The shrinkage and firming of berries by the syrup was welcomed.

Quick freezing is desirable for many fruit and vegetable products, to avoid changes prior to freezing and to minimize damage to texture by the freezing process itself. Damage to texture may result if slowly formed, large crystals of ice rupture cells. Slow freezing may also effect

an irreversible dehydration of colloidal gels. Leakage and collapse tests have been developed as a means of estimating tissue damage resulting from the freezing process. For fruit pulps, to be eaten as frozen confections or desserts, rapid freezing is important in order to secure smooth texture and avoid graininess. Commercial operators must consider freezing rates in reference to products being packed.

Storage temperatures below 10° F. are necessary to maintain the quality of most products. Above that temperature enzyme action may cause fairly rapid deterioration. The effect of temperature variations in causing ice crystal growth is also accentuated when unfrozen syrups are present at the higher temperatures. Orange juice, English peas, lima and string beans and broccoli frozen in our laboratory have been found in satisfactory condition after twelve months of commercial storage in sealed cans at 10° F. Sweet corn held under similar conditions showed evidence of deterioration, but some varieties were still acceptable.

A number of materials are used for packaging frozen fruits and vegetables. Tin plate and glass containers, particularly when vacuum sealed, afford the greatest degree of protection against evaporation, oxidation and absorption of foreign odors. Sealed containers are indispensable for frozen orange juice to be stored for any length of time. Unfortunately, buyers have become used to sterilized food products in sealed containers, and expect frozen products to keep indefinitely until the seal is broken, regardless of the temperature.

Transparent latex rubber films and lacquered cellophane afford the next greatest degree of protection against drying and absorption of odors from storage room atmosphere. Paper coated with paraffin is more porous at low temperatures, and orange juice stored in waxed paper cups shows excessive evaporation and oxidation after five months storage.

Combination packages consisting of lacquered cellophane bags in waxed paper cartons wrapped with waxed glassine are commonly used for packages containing less than five pounds of frozen vegetables. Heavy waxed cardboard tubs and slip top cans are frequently used as containers for five and ten pounds of vegetables. Cans and barrels are used for storing larger amounts. Container manufacturers are experimenting with new containers for frozen foods.

VARIETAL ADAPTABILITY IN SOUTH TEXAS:

Citrus Juice: In tests made during two seasons, Valencia orange juice which had been reamed, screened, deaerated and sealed in air tight containers showed excellent quality after one year in commercial storage at 10° F. Pineapple, Hamlin and Parson Brown orange juices are satisfactory, and Navel orange juice is fairly satisfactory in tests made to date. Frozen grapefruit juice and sections show no outstanding advantage over properly canned products of the same fruit.

Peas: Freezing varieties must be sweet and possess brilliant color when blanched. Among the promising varieties tried were Dark Podded Thomas Laxton, Laxton's Progress, Thomas Laxton, Glacier, Teton, Gradus Improved, Extra Early Gradus, World's Record, President Wilson and Hundredfold. (Mardelah outyielded Ace and Early Harvest among canning varieties which were tried.)

Floaters in one-percent brine and peas larger than No. 6's were discarded. The balance were blanched 1 minute at 212°, cooled, and frozen both dry and covered with 2-percent brine. Little difference was observed in the two packs of peas. Additional varieties will be added in subsequent tests.

String Beans: String beans were planted October 2nd. Promising varieties include Bountiful, Giant Stringless Green Pod, Keeney's Stringless Greenpod, Full Measure, Blue Lake and Asgrow Stringless Greenpod.

Beans were blanched 3 to 4 minutes at 212° F. The time was varied with the size and texture of the beans and no evidence was obtained of improper blanching. Some beans were cut, others were packed whole, like asparagus. Some were packed dry, others were covered with 2-percent brine.

Other dwarf, green-podded and wax-podded varieties of beans should be included in later tests.

Broccoli: Only side shoots from Italian sprouting broccoli were frozen. Quality was outstanding in packs blanched 3 and 5 minutes. The center shoot is nipped off, and if side shoots are all harvested upon reaching a length of 4 inches, plants continue to bear until injured by insects, disease, or unfavorable weather. Planting may be made any time after September 1st, as broccoli produces well as a fall, winter or spring crop if weather conditions are favorable.

Lima Beans: Eight bush-type varieties were planted on March 7th, lima beans being adaptable to production as a spring crop. Henderson yielded the largest quantity of any variety tried. Among the more promising varieties were:- Henderson, Baby Potato, Wood's Prolific, Long Podded Lima, Droer's Bush and New Wonder. Fordhook, Wilson's Improved and bush varieties will be included in later tests.

Small lima beans were shelled in a mechanical sheller, larger varieties by hand. Beans were separated into groups which would:

1. Float in water (discarded.)
2. Sink in water; float in 8-percent brine.
3. Sink in 8-percent brine; float in 18-percent brine.
4. Sink in 18-percent brine.

Varieties reacted differently to this gravity separation and no general conclusion may be drawn from these preliminary tests except that this type of grading will probably be valuable in preparing some varieties.

Partial size grading was applied to some varieties. Beans were blanched at 212° F. 2 to 4 minutes, depending on the size and texture. No evidence of improper blanching was obtained. Most of the beans had satisfactory to excellent quality when frozen dry or in 2-percent brine.

Sweet Corn: Eighteen varieties of sweet corn were planted on February 12, March 7, and March 11. Corn planted in February produced most heavily in this year's tests. In general, it may be stated that resistance to ear worm damage, as provided by a long tight husk, appears to be a requisite for adaptability under south Texas conditions. In these preliminary tests the following varieties produced promising yields of sweet corn of satisfactory canning and freezing quality: Iowa hybrids 191 x 1948, 128 x 1071, 1612 x 1445, P39 x 145, P51 x 145, and 04 x 145; Georgia varieties 429 and 496, Sweet Snowflake, Honey June and Sure Cropper Sugar.

Corn was husked, silked and trimmed by hand and blanched in steam or boiling water for 4 minutes, cooled, placed in the can and frozen. The flavor of fresh corn was excellent but after frozen storage showed deterioration in all varieties, indicating that blanching time was inadequate and should be increased to 7 or 8 minutes. Corn canned from the Iowa hybrids compared favorably with fancy commercial packs.

Records of the Texas Experiment Station include: weather, preparation of soil, date and method of planting, crop management, date of harvest, yield, and description of plants and crops.

Records of the U. S. Fruit and Vegetable Products Laboratory include total yield, shrinkage after cleaning, trimming and sorting, method of grading, time and temperature of blanching, method of packing, freezing temperature and the flavor, color and texture of fresh and frozen products before and after cooking. All products were frozen in cans immersed in alcohol cooled to -40° F. to -60° F. with solid carbon dioxide.

SUMMARY:

This progress report summarizes observations on the canning, freezing, drying and fermentation of, and the recovery of by-products from, fruit and vegetable crops produced in Texas.

Canning and freezing studies are in co-operation with the Texas Experiment Station, and the waste disposal work is in co-operation with the Texas State Board of Health.

A new laboratory building has just been completed and new equipment is being secured. It is proposed to extend the investigation of the utilization of fruits and vegetables as rapidly as facilities will permit.

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