Sparks

TECHNICAL BULLETIN 30 MAY 1956

VITAMIN VALUES OF FOODS USED IN HAWAII

CAREY D. MILLER
BARBARA BRANTHOOVER
NAO SEKIGUCHI
HELEN DENNING
ADELIA BAUER

HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII

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FOREWORD

This bulletin constitutes a revised and enlarged edition of Technical Bulletin 6, published in 1947, which presented values on vitamin A, thiamine, and ascorbic acid of local foods. With few exceptions, the data in this edition represent new assays of the vitamins by chemical or microbiological methods, and include figures for moisture, carotene, thiamine, riboflavin, niacin, and ascorbic acid. The technique for carotene analyses had not been perfected in this laboratory when work was first begun on the B-vitamin assays, which necessitated some separate samples for the determination of provitamin A. It was originally planned to use the figures for ascorbic acid from Technical Bulletin 6, as they were determined by the dye titration method, whereas the values for vitamin A and thiamine had been determined biologically. However, as the work progressed, it seemed wise to redetermine the ascorbic acid of some foods, which accounts, in part, for the number of different samples used.

To simplify the main table (table 1), only one figure is given for the moisture value of each food, although moisture was determined on most of the samples assayed. The ascorbic acid (or other values) was calculated to the same moisture basis as the sample on which most of the vitamins were determined. Since the samples used are completely described in the Appendix, reference to these notes for each food will provide information on the products analyzed.

Helen Denning and Adelia Bauer carried out about one-third of the assays for thiamine, riboflavin, and niacin. They were succeeded by Barbara Branthoover and Nao Sekiguchi, who completed the analyses. We are indebted to Dr. Florence Pen of this department who worked out the details of the method used for carotene and who made more than one-third of the carotene and the three vitamin A determinations. She also checked many of the calculations. Nao Sekiguchi determined about two-thirds of the carotene values.

Barbara Branthoover carried out most of the special ascorbic acid studies under my direction and took the major responsibility for compiling the data in table 1 and the description of the samples. Both Miss Sekiguchi and Miss Branthoover assisted in the preparation of the manuscript.

CAREY D. MILLER
Head, Foods and Nutrition Department

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We are indebted to a number of individuals and agencies for their cooperation in supplying materials for analyses: Mr. Frank R. Oberhansley, former Superintendent of Hawaii National Park, shipped the ohelo berries (1953); Dr. A. J. Mangelsdorf, geneticist at Hawaiian Sugar Planters' Association Experiment Station, supplied mangos of the Joe Welch variety from Molokai; the Hawaii Growers Cooperative gave several samples of vegetables, gratis; Mr. Shiro Takei, Assistant Specialist in agricultural economics, Extension Service, made arrangements for and personally delivered several samples direct from the grower or wholesaler; the Hawaiian Macadamia Nut Company donated fresh and roasted macadamia nuts; the territorial Board of Agriculture and Forestry, through Mr. Albert W. Duvel, gave some mango samples; Miss Beatrice Krauss of the Pineapple Research Institute supplied fresh pineapple; Mr. Donald Mitchell of Kamehameha Schools aided in obtaining the carissa; and a number of people gave single samples of fruit from their private gardens.

Hawaii Agricultural Experiment Station departments rendered the following assistance: Vegetable Crops furnished a number of vegetable samples for analyses and, in a few cases, even planted the crop especially for our use; Horticulture and Plant Physiology furnished a number of fruits; Agronomy supplied the pigeonpeas, and Entomology the lima beans. Mr. Edward Fukunaga shipped several varieties of avocados from the Kona Station. Staff members of the Vegetable Crops and Horticulture departments were especially helpful in assigning the proper scientific names to the samples.

The authors wish to thank Mildred Ige and Gladys Haida for their excellent and faithful technical assistance in the laboratory, and Mrs. Ige and Mrs. Amy Miyahira for their help in preparing and checking tables.

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INTRODUCTION

In addition to many familiar American foods, there are available in Hawaii many foods of tropical and semitropical origin, and foods characteristic of the diets of the racial groups which make up the population of the Islands. To provide information about the vitamin content of these foods, and to determine the comparative vitamin value of fruits and vegetables produced locally with those produced elsewhere, a general survey of the vitamin values of foods in Hawaii was undertaken. The results of this survey are presented in this bulletin.

After a brief discussion of the vitamins and their importance in nutrition, and a statement of the methods used, the vitamin values for a large number of foods are summarized in table form, followed by comments on the results and comparison with published values. The vitamins studied were carotene (the biologically active carotenoid pigments which are the precursors of vitamin A), thiamine, riboflavin, niacin (nicotinic acid), and ascorbic acid.

Several detailed studies of local foods for their ascorbic acid value and/or their B-vitamin content are also included.

Supporting data regarding number, size, source, and treatment of the samples are included in the Appendix.

BRIEF SURVEY OF PRESENT KNOWLEDGE OF VITAMINS

VITAMINS DEFINED

Vitamins are nutritionally essential substances, required in relatively small amounts, that are neither minerals, carbohydrates, lipids, proteins, nor their derivatives (*44*). Chemically, each vitamin has a different structure unrelated to that of others. The system of designating the vitamins by letters of the alphabet or as specific factors, initiated shortly after their discovery, has continued until each vitamin has been chemically identified. For vitamins A and D no generally accepted chemical names have ever been adopted though their chemical structures have been known for almost 25 years.

Chemical identification of the vitamins and their availability in pure form have permitted extensive and valuable research as to their mode of action in the body and their use as therapeutic agents. Nevertheless, authorities in the field of nutrition agree that the best sources of the vitamins are well-selected and properly prepared foods, because they furnish not only the known vitamins but the unknown and unidentified dietary factors (*11, 38*).

CLASSIFICATION AND NOMENCLATURE

The vitamins are commonly classified in two general groups—water-soluble and fat-soluble. Recent reviews (*1, 2*) include 12 chemically identified substances as the water-soluble vitamins and 4 as fat-soluble vitamins, with as yet unidentified substances in each group.

The water-soluble vitamins include vitamin C (ascorbic acid) and all the members of the "B family" or vitamin B complex. Under the B vitamins are listed thiamine, riboflavin, nicotinic acid, pantothenic acid, pyridoxine, biotin, folic acid, B_{12}, *p*-aminobenzoic acid, choline, and inositol. R. J. Williams has pointed out the universal distribution of the B vitamins in all living matter, from the lowest organisms up the scale to the most highly developed forms, and the ability of the B vitamins to stimulate growth in all forms of life. In 1943, he stated, "presumably they are constituents of fundamental catalytic systems which are essential to living processes" (*44*) and additional research since that time has only served to prove and substantiate this general observation (*2, 45*).

The term ascorbic acid is now quite generally used for vitamin C though some texts and reviews still use both terms interchangeably (*1, 38*). Ascorbic acid is recognized as occurring in foods in two forms, *l*-ascorbic acid and dehydroascorbic acid, the oxidized form. Most of the naturally occurring vitamin is *l*-ascorbic acid, whereas dehydroascorbic acid may or may not be present in small amounts. The body is able to utilize both forms of the vitamin. In this bulletin the values are for reduced or *l*-ascorbic acid only.

The fat-soluble vitamins are A, D. E, and K, only one of which, vitamin E, is commonly referred to by its chemical name, tocopherol. One deterrent to names other than the alphabetical ones for the fat-soluble vitamins is their occurrence in several different forms. Thus far it has been clearly established that there are two naturally occurring and effective forms of vitamin A, two of vitamin D, four of vitamin E, and two of vitamin K, which are referred to as A_1, A_2, D_2, D_3, etc. (*38*). In addition, there are other substances, natural and synthetic, that exhibit some of the properties of the well-established forms.

REASONS FOR STUDYING ONLY FIVE VITAMINS

The occurrence of five vitamins—vitamin A or its precursors, thiamine, riboflavin, niacin, and ascorbic acid—has been studied in foods produced or widely used in Hawaii. Methods for these five have been well established and tested. If the foods eaten daily are properly selected, they will supply not only these five vitamins, but all the other vitamins, known and unknown, with the possible exception of vitamin D. Vitamin D for the infant and small child should be prescribed by the physician, and adults can obtain a sufficient amount from foods commonly used, plus exposure to Hawaii sunshine.

NUTRITIONAL SIGNIFICANCE OF THE VITAMINS

The physiological functions of, the occurrence and stability of, and the requirements and allowances for each of these five vitamins will be briefly discussed. For additional information on these and other vitamins, the reader is referred to the monthly issues of *Nutrition Reviews*, the *Annual Review of Biochemistry*, and books such as *The Vitamins—Chemistry, Physiology, Pathology*, edited by Sebrell and Harris (*37*).

Vitamin A

Vitamin A promotes growth and helps keep the epithelial tissues of the skin and of the mucous membranes lining different parts of the body in a healthy condition. It is necessary for the formation of good teeth and bones. It is also essential for normal vision, and a deficiency will result in night blindness. If more vitamin A is taken each day than is needed, the body is able to store it in the liver and other tissues.

Vitamin A is an almost colorless substance, soluble in fats and organic solvents, and is found only in foods of animal origin. The vitamin A values of plants are due to their content of orange-yellow pigments or carotenoids, which are often called precursors or provitamins, and which can be changed to vitamin A in the animal body. The term "vitamin A value" is used to designate both the true vitamin A and the orange-yellow pigments that can be changed to vitamin A.

There are four well-known precursors of vitamin A, alpha-, beta-, and gamma-carotene, and cryptoxanthin. In most fruits and vegetables, beta-carotene is the most important precursor, but in papaya it is cryptoxanthin which constitutes approximately 80 percent of the total pigment (*12*). Other yellow pigments appear to have little or no value as precursors of vitamin A and evidently have no influence upon the utilization of the effective precursors (*8*).

Just exactly why the carotene of green vegetables, especially the green leafy ones, appears to be used approximately twice as well as the carotene of yellow vegetables such as sweetpotatoes is still not fully understood (*8*). Eventually it should be possible, as Callison and co-workers have suggested, to derive factors for "each class of carotene-bearing plant foods" in order to calculate the quantity of biologically effective precursors from the chemically determined carotenes, cryptoxanthin, and possibly other pigments (*7*).

Since it is a generally accepted estimate (*30*) that about two-thirds of our vitamin A comes from plant foods, the green and yellow vegetables are excellent and economical sources of this vitamin. White or bleached vegetables contain little or none of the precursor. Deep-green vegetables, such as turnip greens, Chinese spinach, and luau, contain 10 times as much provitamin A as faintly green or bleached vegetables, such as cabbage or lettuce.

Recent reports indicate that the kind and character of other nutrients in the diet, such as protein, fat, and vitamin B_{12} (*13*), may affect the absorption and utilization of carotene, and much remains to be learned regarding all the factors that influence or control its storage and transformation to vitamin A (*31*).

Foods from animal sources, such as milk, eggs, liver, and kidney, contain both vitamin A and precursors.

Both forms, vitamin A and carotenoid pigments, in foods are relatively stable and are not readily destroyed by the usual methods of food preparation and preservation. Vitamin A per se is readily destroyed by oxidation, however; and in rancid fats, or foods containing rancid fats, the chemical constitution of vitamin A is readily altered and its physiological effectiveness is lost.

Thiamine (Vitamin B_1)

Gradually the special physiological functions of each of the B vitamins are being determined. Thiamine and a number of the other B vitamins are vitally concerned in the complex metabolic processes that are constantly going on in all the cells of the body. Thiamine is essential for growth, promotes the appetite, and helps to keep the digestive tract and the nervous system in a healthy condition.

Although thiamine is widely distributed in foods, it occurs in extremely small amounts—0.1 to 4 parts per million (*43*). Its complete extraction from the food is an essential step prior to its determination by the thiochrome method now generally used.

Since thiamine is stored only to a limited extent and the excess over daily needs is normally eliminated in the urine, a proper choice of foods to insure a regular intake is recommended.

The best food sources of thiamine are the whole grains, lean pork, legumes, and nuts. As a class of foods, fresh fruits and vegetables are not considered good sources of thiamine. However, when compared on the calorie basis, such foods as potatoes, sweetpotatoes, taro, poi, pumpkin, and winter-type squash are remarkably good sources (see page 31). Such products as wheat germ, rice middlings, and certain types of dried yeast constitute the most concentrated naturally occurring sources of thiamine and are also good sources of some of the other B vitamins.

Thiamine is sensitive to heat, alkali, and oxidation. The greatest losses of thiamine occur as a result of (1) milling grains, if all the bran and germ are discarded; (2) heating to a high temperature, such as is required in canning and cooking some foods; (3) discarding water in which foods have been soaked, cooked, or canned.

Riboflavin (Vitamin B_2)

Riboflavin, like thiamine, is essential for the normal functioning of the complex enzyme-coenzyme systems in body cells. It is considered to be essential for growth and normal development at all stages, including the embryo. Experiments, especially of Sherman and co-workers, have emphasized the relationship of this vitamin to extending the prime of life and delaying the onset of senility (*38*).

Riboflavin helps to maintain the mouth, the skin, and the eyes in a healthy condition and, in general, promotes resistance of the body to infections.

Pure riboflavin is a yellow, crystalline substance. Much of the color in the whites of eggs, the whey of milk, and the liquid that drains from tofu is due to the presence of riboflavin.

Like thiamine, it is widely distributed in plant and animal tissue, and is often closely bound to protein and amino acids from which it must be freed before it can be determined by chemical means. The best sources of riboflavin are the animal protein foods like milk, eggs, fish, and meat, and green leafy vegetables such as spinach, turnip greens, taro leaves, and sweetpotato tops. Fruits and vegetables as a group are not rich sources of riboflavin but some are relatively good (see page 31). Natural foods that contain the largest amounts of riboflavin are animal organs like liver, kidney, and heart, and the viscera of such shellfish as *opihi,* the Hawaii limpet.

Riboflavin is sensitive to light but relatively stable to heat. Since it is a water-soluble vitamin, the greatest loss in cooking procedures is likely to occur when water in which foods are cooked is discarded.

Niacin (Nicotinic acid)

Niacin is one of the important water-soluble vitamins that was known as a pure chemical substance long before its function as a vitamin was discovered.

Like thiamine and riboflavin, it is essential for growth and for normal oxidation processes in the body tissues. Niacin is required to prevent or to cure certain of the symptoms of the disease known as pellagra. (Some believe pellagra to be caused by a multiple nutritional deficiency.)

It has been proved that the amino acid tryptophane can act as a precursor of niacin and that the amount of niacin required is probably dependent upon the amount of tryptophane in the diet. Nevertheless "standards" or "allowances" for this vitamin have been established as a guide in planning or checking dietaries (*30*).

Fruits and vegetables, on the whole, are poor sources of niacin though there are some notable exceptions among the legumes and green leafy vegetables (see page 33). Meats are considered the best sources of niacin in the diet, and peanuts and yeast are unusually rich in this vitamin.

In comparison with thiamine, niacin is very stable to heat but it may be greatly reduced when grains (especially rice and wheat) are highly milled and when water, in which vegetables are cooked, is discarded.

Ascorbic Acid (Vitamin C)

The first vitamin chemically identified and synthesized was ascorbic acid. It is a white crystalline material readily soluble in water and is more easily destroyed by oxidation than any of the other vitamins. Light, heat, alkali, and copper increase the rate of destruction by oxidation. Ascorbic acid is more stable in acid than in neutral media.

Just how ascorbic acid functions in body processes has not been fully determined (*32*), but it has been clearly established that this vitamin prevents scurvy, and is required for normal growth and health at all ages. Ascorbic acid plays an important role in the development of the teeth and the maintenance of healthy gums.

Experiments in many laboratories have clearly established that ascorbic acid controls the production and normal functioning of material around and between the body cells (intercellular substance). When this function fails in the young or old, scurvy will occur. Man shares with the monkey and the guinea pig the inability to make his own ascorbic acid. It has been proved that other animals, such as the dog, rat, and cow, have a definite need for ascorbic acid but that they are able to synthesize it and store small amounts in various organs. Because the human body can store little ascorbic acid, foods that will supply an adequate amount should be included in the diet each day.

Ascorbic acid is especially important for the bottle-fed baby because sterilized or pasteurized milk mixtures contain little or no ascorbic acid, whereas human milk supplies adequate amounts for the nursing infant if the mother has a proper diet.

Dry grains and cereal products, legumes, meats, fish, eggs, and all fats furnish no ascorbic acid. Fruits and vegetables, the chief food sources, vary greatly in their content of this vitamin. In addition, methods of storage, transportation, and preparation all influence markedly the ascorbic acid content of fruits and vegetables as they reach the consumer's plate.

REQUIREMENTS AND ALLOWANCES

Daily allowances for six of the well-established and more fully studied vitamins have been recommended by the Food and Nutrition Board of the National Research Council (*30*). These allowances are greater than the supposed requirements for several reasons. In addition to the natural variations in the vitamin content of foods due to such factors as variety and environment, there may be large losses as a result of storage, cooking, and processing, which affect the vitamin content of the foods as eaten. Moreover, absorption and utilization may differ even in normal individuals. Differences in metabolic rates, febrile conditions, and infections may further change the requirements. Experiments with humans and other animals have clearly demonstrated an increased need for vitamins during pregnancy and lactation.

The daily allowances recommended by the National Research Council for a man 25 years of age for five of the vitamins discussed in this bulletin are:

5,000 International Units of Vitamin A
1.6 milligrams of thiamine
1.6 milligrams of riboflavin
16 milligrams of niacin
75 milligrams of ascorbic acid

For complete data on the allowances for these and other vitamins, for different ages and sexes, the tables prepared by the Board should be consulted (*30*).

STUDY OF VITAMIN VALUES OF FOODS IN HAWAII

EXPERIMENTAL PROCEDURE

Preparation and Sampling of Fruits and Vegetables for Vitamin Assays

The edible portions of foods, prepared as for human consumption, were used for all analyses. The foods analyzed, their variety (if known), sample size, description, preparation, cooking method, and the percentage waste, are listed in the Appendix.

Edible portions of the fruits and vegetables were washed and freed of excess water by shaking or patting between clean cheesecloths or by air drying with the aid of an electric fan. Foods were analyzed in the raw state, and if eaten cooked, also in the cooked state.

Unless otherwise indicated (see Appendix: pages 62, 68, 74, 82, 83, 84, 86, 87, 89, 91 for samples cooked in boiling water), the procedure for cooking was as follows:

> The vegetables were put into aluminum pans, 3 inches deep and 9 inches in diameter, which were placed on a wire rack 2½ inches above the bottom of an 11-quart pressure cooker containing hot water to a depth of 1½ inches. Sometimes a single pan was used. If two pans were used, one was placed above the other. The cooker lid was placed on top but was not screwed in place. The vegetables were **not** cooked under pressure at any time. The cooking period was counted from the time steam began to issue from the pet cock. This procedure afforded a uniform method that could be readily duplicated, and prevented loss of juices and any marked changes in weight. The small amount of water that condensed in the cooking pan during steaming was included as part of the cooked sample.

When work was first started on this bulletin, foods to be assayed were finely chopped and thoroughly mixed before portions were removed for the various vitamin determinations. Later, another procedure was adopted for the water-soluble vitamins. The vegetable or fruit to be assayed was coarsely cut and mixed. For some foods (mostly fruits and vegetables of high water content) which would blend readily, the entire sample (except that used for ascorbic acid) was blended in a Waring blendor. Using 1 part cut or blended sample (usually 100 grams) and 1 part or more extracting acid, a slurry was prepared from which aliquots were taken for assay. This decreased the chances for oxidation and afforded an efficient method of obtaining a uniform sample.

For carotene and moisture determinations representative samples were finely chopped.

Analytical Methods

Moisture. The percentage moisture of foods was determined in duplicate. From 4.5 to 5.5 grams of finely chopped sample were dried for 48 hours in an electric oven at 70° to 80° C., except fruits which were dried below 70° C. The samples were cooled in a vacuum desiccator (over dehydrite or silica gel) which was evacuated for 15 minutes and allowed to stand for another 24 hours. The loss in weight was calculated and reported as percent moisture.

Carotene (Provitamin A). The chromatographic method described in *Methods of Vitamin Assay* (4) was used with slight modifications. This procedure depends upon the separation of the biologically active carotenoid pigments from the nonactive pigments in an extract by an adsorbent with varying affinities for the different pigments. The extracting solvents were 1 percent alcoholic potassium hydroxide, acetone, and petroleum ether; the adsorbent, a 1:1 mixture of magnesium oxide and Hiflow Super Cel; and the eluent, 3 to 10 percent acetone in petroleum ether. The color intensity was evaluated by measuring the light transmission with a 440 *mu* filter using an Evelyn colorimeter, and the carotene concentration determined by reference to a calibration curve (90 percent beta- and 10 percent alpha-carotene mixture dissolved in petroleum ether). Three to 20 grams of sample were assayed in triplicate plus a fourth aliquot as a recovery test.

Vitamin A. The colorimetric method (Carr-Price Blue Color) as outlined in *Methods of Vitamin Assay* was used, employing the U.S.P. Vitamin A Reference Standard for the calibration curve (4).

Thiamine. The thiochrome procedure described in *Methods of Vitamin Assay* (4) was used. This procedure depends upon the oxidation of thiamine to thiochrome, which fluoresces in ultraviolet light. Under standard conditions and in the absence of other fluorescing substances, the fluorescence is proportional to the thiochrome present and hence to the thiamine in the original solution.

Nearly one-third of the samples were assayed in duplicate, the remainder in triplicate, plus a third or fourth aliquot as a recovery test in all but a few instances.

Riboflavin. At the beginning of this study, both the microbiological (using *Lactobacillus casei*) and chemical methods as described in *Methods of Vitamin Assay* (4) were used. However, due to lack of agreement in the results and the apparent superiority of the chemical method, the microbiological procedure was discontinued. Nearly one-third of the assays were determined on finely chopped samples in duplicate with a third aliquot as a recovery test, and the remainder on a slurry (1 part sample and 2.5 parts 0.1 N hydrochloric acid) in triplicate and with recovery tests. All, except the 23 foods indicated by § in table 1, were assayed by chemical means.

Niacin. Niacin was determined by the microbiological assay procedure using *Lactobacillus arabinosus* as outlined in *Methods of Vitamin Assay*, 1st edition, and later as modified in the 2nd edition (4). Samples were assayed in duplicate with a third aliquot as a recovery test. The extracting acid was 1 N sulfuric acid.

Ascorbic Acid. The reduced form of ascorbic acid was determined by use of the dye (2,6-dichlorophenolindophenol) titration method or photoelectric colorimeter method. At first, duplicate 20- to 30-gram samples were blended with 100 milliliters of 3 percent metaphosphoric acid, filtered, and aliquots titrated with the dye (nine food samples). Later, the procedure outlined in *Methods of Vitamin Assay*, 2nd edition, was used with some modifications. A 100-gram sample was blended with an equal amount of 6 percent metaphosphoric acid. Duplicate aliquots of the slurry were made up to 100 milliliters with 3 percent metaphosphoric acid, filtered, and each aliquot titrated in duplicate. Colored solutions, necessitating the use of the Evelyn colorimeter, were extracted as above and determined as outlined by Loeffler and Ponting (*18*) and *Methods of Vitamin Assay* (*4*) with slight modification.

pH Determinations. The pH of fruit pulp or juice was measured on a Beckman pH meter (*3*). A pH 7 buffer was used to standardize the meter.

RESULTS AND DISCUSSION

Vitamin values for foods produced (or widely used) in Hawaii given in table 1 include 214 for carotene, 285 for thiamine, 283 for riboflavin, 285 for niacin, and 230 for ascorbic acid.

A total of 95 fruit and vegetable species were studied, but in many cases various parts of the plant constituted a different food and, therefore, a different sample (e.g., taro leaves and taro corms), and there were often a number of horticultural varieties of the same species (e.g., three of green beans), so that the total number of samples or items amounted to about 300. (For the method of counting total number of samples, see page 58, Appendix.) Three animal foods, milk, eggs, and opihi, were also studied. Foods determined in the raw and cooked state totaled 88.

In evaluating the effect of cooking upon the vitamin content of the foods, if the percentage moisture differed, the vitamin value of the cooked product was recalculated to the same moisture basis as the raw. Comparisons were made using the arbitrary standards listed below.

Because there are many inquiries as to whether the vitamin values of foods produced locally are the same as those grown elsewhere, we have made comparisons when possible with the results published in the United States Department of Agriculture Handbooks 8 and 34 (hereafter referred to as AH 8 and AH 34) (*40, 17*), which in the judgment of the compilers represented averages of typical foods. In order to effect this comparison, an arbitrary means of measuring the differences was set up on the basis of the Recommended Dietary Allowances, hereafter referred to as RDA (*30*). It was decided that only differences greater than one-twentieth of the RDA for each vitamin would be considered. For example, on the basis of the RDA figure of 1.6 milligrams of riboflavin for a man 25 years old, one-twentieth would be 0.08 milligram. Thus, only those values differing more than 0.08 milligram per 100 grams were considered nutritionally significant and were, therefore, true differences. Those island foods whose riboflavin content was within the ±0.08-milligram limit, were considered to be essentially the same as the typical values found in United States Department of Agriculture publications.

For the other vitamins, one-twentieth of the RDA as given on page 8, would be as follows: vitamin A, 250 International Units; thiamine, 0.08 milligram; niacin, 0.8 milligram; and ascorbic acid, 3.75 milligrams, which for comparative purposes was rounded off to 4 milligrams. These figures were used for computing differences between the vitamin values of local foods and those reported in AH 8 and AH 34 in the same manner as just described for riboflavin. Comparisons with our own previously determined values are also made on this basis.

It should be noted that all comparisons with published values are made for raw foods only.

Some of the ascorbic acid values in table 1 are taken from HAES Technical Bulletin 6, *Vitamin Values of Foods in Hawaii*, hereafter referred to as TB 6.

Vitamin A (Carotenoid pigments)

Since plants contain no preformed vitamin A, the vitamin A values for fruits and vegetables given in this bulletin are derived from the carotenoid pigments determined as outlined on p. 10, and are listed in table 1 as carotene.

We have considered 1 microgram of yellow pigments, presumably biologically active carotenoids, to be equivalent to 1 International Unit of vitamin A. It was the opinion of the senior author that such a procedure gave figures more nearly representative of the true nutritional values than to consider 0.6 microgram of pigments as equivalent to 1 International Unit for the following reasons: (1) the method used does not differentiate between beta-carotene, its isomers, cryptoxanthin, and some other pigments which have a lower biological value than beta-carotene or have no vitamin A value (*4, 9*): (2) carotenoids from green vegetables appear to be more efficiently utilized than those from yellow vegetables, and the pigments in the intact vegetables are less well utilized than when extracted and fed in pure form (*7*); (3) the utilization of the pigments by the animal body is influenced by a number of other factors in the diet (*31*); (4) the utilization (absorption and conversion) of carotene in foods, in a series of human digestive experiments, was found to be so poor that a standard for carotene three times that for vitamin A was recommended (*14*).

FOOTNOTES TO TABLE 1.

* Except where stated specifically, vitamin values were determined on the food sample in the raw or natural state, i.e. avocado.

† Moisture content not determined, but assumed to be similar to value given in first column.

‡ Values (ascorbic acid) taken from TB 6.

§ Determined microbiologically.

Note: *Trace* indicates that values were less than 0.010 mg. for carotene, thiamine, and riboflavin; 0.10 mg. for niacin; 1 mg. for ascorbic acid. 0 in the carotene column indicates that in the absence of any yellow pigment it was assumed that no carotene was present. — indicates that no determinations have been made.

TABLE 1. Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Asparagus, green						
Raw	94.8	0.381	0.202	0.160	1.21	25.1
Cooked	93.1	0.766	0.185	0.167	1.37	23.5
Avocado						
Guatemalan						
Kanola	80.8	0.410	0.044	0.103	1.28	7.1
Kashlan	90.2	0.348	0.041	0.124	0.94	4.6†
Manik	55.7	—	0.096	0.057	1.76	—
Guatemalan — Mexican hybrid						
Fuerte	69.5	0.385	0.069	0.116	1.42	2.4†
Guatemalan — West Indian hybrids						
Beardslee	70.4	1.894	0.055	0.108	1.04	3.5
Lehua	75.1	—	—	—	—	6.2
West Indian						
Hulumanu	74.8	—	0.036	0.138	1.80	—
Seyde	83.6	0.588	0.060	0.134	1.91	—
West Indiar type	70.6	1.817	—	—	—	10.1
Banana bud	90.0	0.043	trace	0.021	0.59	1‡
Bananas (cooking)—see Plantains						
Bananas (eating)						
Bluefields	74.7	0.150†	0.026	0.038§	0.61	6‡
Brazilian	68.5	0.150	0.039	0.072	0.56	13.9
Chinese	79.2	0.082†	0.026	0.041	0.61	8‡
Ice Cream	66.2	trace	0.032	0.038	0.45	18.0
Lacatan	70.6	0.101	0.043	0.080	0.60	3.7
Red Cuban	78.8	0.085	0.038	0.050	0.58	1.2
Bean sprouts, mung						
Raw	89.8	trace	0.121	0.103	0.75	15‡
Cooked	89.3	trace	0.120	0.102	0.79	6‡
Bean sprouts, soy						
Raw	81.8	0.028	0.174	0.141	0.74	6.7
Cooked	80.2	0.041	0.188	0.145	0.78	3.0

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBOFLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Beans, green						
Hawaiian Wonder						
Raw	90.4	0.122†	0.049	0.114	0.64	27.4
Cooked	90.0	0.250†	0.049	0.116	0.64	15.8
Kentucky Wonder						
Raw	92.4	0.366	0.045	0.114	0.46	22.2
Cooked	92.1	0.417	0.048	0.125	0.47	13.1
Lualualei						
Raw	93.0	0.185	0.055	0.079	0.40	22.7
Cooked	92.6	0.208	0.053	0.080	0.44	12.9
Beans, green lima						
Raw	76.6	0.164	0.218	0.125	1.61	29.9
Cooked	76.2	0.160	0.246	0.150	1.49	26.4
Beans, hyacinth						
Raw	90.0	0.109	0.056	0.092	0.54	12.8
Cooked	90.3	0.142	0.056	0.088	0.47	4.2
Beans, soy—see Soybeans						
Beans, yellow wax						
Raw	92.0	0.049	0.065	0.115	0.64	18.5
Cooked	93.9	0.044	0.073	0.126	0.64	12.1
Beet greens						
Raw	92.6	1.902	0.048	0.170	0.35	8.5†
Cooked	92.8	2.479	0.050	0.181	0.37	0
Beets						
Raw	88.4	trace	0.028	0.045§	0.36	4.0
Cooked	88.6	trace	0.013	0.034§	0.19	1.8
Belembe (Tahitian taro)						
Raw	89.1	2.045	0.062	0.244	0.99	96‡
Cooked	91.2	4.884	0.044	0.198	0.46	38‡
Bitter melon						
Fruit						
Raw	93.8	0.027	0.063	0.053	0.28	63‡
Cooked	93.7	0.113	0.051	0.053	0.26	33‡

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
Bitter melon (*cont.*)	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Leafy tender tips						
Raw	88.0	1.734	0.181	0.362	1.12	88‡
Cooked	89.1	2.475	0.163	0.313	1.09	20‡
Breadfruit						
Green						
Raw	69.3	0.000	0.125	0.055	0.88	16.9
Cooked	69.2	0.000	0.122	0.058	0.67	9.9
Ripe						
Raw	67.3	0.035†	0.099	0.054	1.32	13.2
Cooked	65.2	0.026†	0.109	0.056	1.31	10.2
Broccoli						
Raw	89.6	0.565†	0.127	0.196	0.68	111.9
Cooked	88.7	0.870†	0.125	0.215	1.00	80.2
Burdock root (gobo)						
Raw	74.3	0	0.045	0.056	0.32	trace
Cooked	73.6	0	0.039	0.058	0.34	trace
Cabbage						
Chinese or celery cabbage						
Raw	96.2	0.053	0.047	0.043§	0.50	23.3
Cooked	96.7	0.048	0.044	0.044§	0.50	15.6
Green mustard						
Raw	93.8	0.775	0.066	0.120	0.68	61.0
Cooked	93.4	1.330	0.070	0.112	0.70	40.8
Head, Copenhagen						
Raw	93.8	0.035	0.032	0.031	0.24	53.2
Cooked	92.8	0.117	0.032	0.034	0.26	40.6
White mustard						
Sample 1						
Raw	95.7	1.501†	0.045	0.066	0.70	28.8
Cooked	95.4	1.906†	0.044	0.059	0.58	18.9
Sample 2, pickling study						
Raw	95.4	0.592	0.040	0.080	0.80	30.8
Salt-pickled	89.8	0.971	0.036	0.094	0.74	trace

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Cabbage, White mustard, Sample 2 (*cont.*)						
Bran-salt-pickled	89.2	1.380	0.135	0.115	1.85	1.5
Sample 3 Commercial salt-pickled	90.1	1.028	0.026	0.066	0.54	—
Cactus fruit	82.8	trace	0.017	0.029	0.40	28.2
Carambola	90.2	0.021	0.040	0.044	0.71	35‡
Carissa	82.6	0.023	0.036	0.061	0.23	53.4
Carrots						
Raw	91.0	7.075	0.066	0.031	0.70	5.2
Cooked	90.0	8.206	0.063	0.039	0.71	4.7
Cauliflower						
Raw	90.3	0.020†	0.087	0.104	0.72	58.8†
Cooked	90.4	0.026†	0.096	0.100	0.84	42.7†
Celery						
Sample 1						
Raw	95.6	—	0.026	0.027	0.32	—
Cooked	94.6	—	0.025	0.028	0.28	—
Sample 2						
Raw	94.0	0.050	0.025	0.025	0.24	8.3
Cooked	94.0	0.039	0.028	0.025	0.28	4.8
Chard						
Raw	95.4	1.171	0.031	0.084	0.22	15‡
Cooked	94.6	1.318	0.041	0.082	0.23	5‡
Chayote						
Raw	95.6	0.022	0.013	0.035	0.31	7.4†
Cooked	94.7	0.038	0.014	0.041	0.18	5.1†
Coconut						
Cream						
Sample 1 (without water)	53.9	0	0.030	trace	0.89	2.8

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

Food*	Moisture	Carotene	Thiamine	Riboflavin	Niacin	Ascorbic Acid
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Coconut, Cream (*cont.*)						
Sample 2 (with water)	65.7	0	0.026	trace	0.76	2.8
Water						
Soft and very soft	—	0	trace	trace	trace	—
Intermediate	—	0	trace	trace	0.22	—
Mature	—	0	—	—	trace	1.4
White meat						
Very soft	83.9	0	0.037	0.018	0.56	—
Soft	76.7	0	0.030	0.020	0.60	—
Intermediate	68.2	0	0.029	0.015	0.56	3‡
Mature	54.7	0	0.027	trace	0.60	0‡
Corn, sweet						
Raw	77.7	0.013†	0.157	0.116	1.79	14.1
Cooked	75.5	0.039†	0.155	0.128	2.10	12.1
Cowpeas						
Fresh pods						
Raw	87.6	0.515	0.148	0.095	1.02	25‡
Cooked	87.8	0.913	0.147	0.111	0.98	16‡
Fresh seeds						
Raw	66.7	0.076	0.392	0.125	2.22	31.0
Cooked	65.4	0.063	0.334	0.143	2.08	24.0
Tender tips						
Raw	89.0	0.712	0.354	0.175	1.13	36‡
Cooked	89.1	0.974	0.292	0.176	1.12	25‡
Cucumber						
Pared	96.4	0.031	0.014	0.020	0.15	10.6
Unpared	96.0	0.104	0.018	0.026	0.20	9.9
Daikon (Japanese radish)						
Sample 1						
Raw	94.1	0	0.026	0.036	0.24	—
Sample 2, pickling study						
Raw	94.6	0	0.017	0.021	0.28	17.5

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
Daikon, Sample 2 (*cont.*)	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Salt-pickled	87.7	0	0.023	0.032	0.31	trace
Bran-salt-pickled	77.2	0	0.454	0.034	4.79	trace
Sample 3						
Commercial salt-pickled	77.1	0	0.037	0.023	0.21	—
Egg						
White	86.8	0	trace	0.433	trace	—
Whole	74.3	0.716 (+598 I.U. vit. A)	0.087	0.412	trace	—
Yolk	48.2	2.250 (+1612 I.U. vit. A)	0.214	0.429	trace	—
Eggplant, Long						
Sample 1						
Raw	92.6	0.074†	0.057	0.054	0.56	trace
Cooked	93.4	0.106†	0.051	0.042	0.54	trace
Sample 2, pickling study						
Raw	90.8	0.100	0.069	0.061	0.64	3.1
Salt-pickled	88.8	0.032	0.057	0.075	0.62	trace
Bran-salt-pickled	88.3	0.010	0.138	0.069	1.57	trace
Sample 3						
Commercial salt-pickled	89.6	trace	0.037	0.058	0.44	—
Eggplant, Round						
Raw	91.2	0.028	0.059	0.048	0.76	2.1
Cooked	91.3	0.053	0.049	0.042	0.78	trace
Figs, Brown Turkey	86.5	0.062	0.034	0.037	0.32	2‡

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Goa or winged bean						
Raw	92.8	0.330	0.220	0.089	0.68	trace‡
Cooked	92.2	0.387	0.192	0.087	0.66	0‡
Gourd, dishcloth						
Raw	95.0	0.022	0.043	0.045	0.24	7.4†
Cooked	94.2	0.026	0.046	0.042	0.26	5.7†
Gourd, white flowered						
Raw	95.1	0	0.029	0.022	0.34†	10.2
Cooked	94.9	0	0.029	0.022	0.38†	1.8
Grapes, Isabella						
Pulp only	88.8	0.065	0.047	0.031	0.12	2‡
Whole	89.1	0.085	0.047	0.034	0.19	5‡
Guava, Cattley						
Red (strawberry), seeds removed	84.3	0.145	0.034	0.029	0.64	33‡
Yellow, seeds removed	83.4	trace	0.029	0.031	0.42	21.0
Guava, common						
Sample 1, seeds removed	87.9	0.213	0.041	0.044	1.09	—
Sample 2, seeds removed	87.6	0.000	0.040	0.035	0.84	—
Sample 3, seeds removed	91.2	0.030	0.036	0.044	0.78	—
Sample 4, whole, seeds included	82.9	—	0.035	0.050	0.57	70–350‡
Horseradish tree						
Leaflets and tender tips						
Raw	75.4	7.564	0.257	0.660	2.24	134‡
Cooked	75.0	8.132	0.257	0.590	2.29	36‡

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

Food*	Moisture	Carotene	Thiamine	Riboflavin	Niacin	Ascorbic Acid
Horseradish tree (*cont.*)	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Pods						
Raw	87.4	0.074	0.053	0.074	0.63	172‡
Cooked	89.5	0.070†	0.046	0.068	0.58	126‡
Java plum (jambolan)						
Purple flesh	84.9	0.000	trace	—	0.24	27‡
Jute (Filipino spinach)						
Raw	85.7	5.388	0.129	0.265	1.21	36‡
Cooked	84.6	6.850	0.120	0.255	1.18	1‡
Ketambilla (Ceylon gooseberry)	86.0	0.237	0.012	0.052	0.25	66.3
Kombu						
Raw, washed	81.6	0.014	0.033	0.092	0.22	trace
Cooked	90.5	trace	0.017	0.041	0.11	trace
Cooking water	—	—	trace	0.016	trace	trace
Kumquot	82.2	—	—	—	—	39.2
Lettuce						
Iceberg (head)	95.8	0.032	0.042	0.031	0.20	1.7
Manoa (semi-head)	96.7	1.229	0.052	0.066	0.33	8‡
Lemon, juice	—	0	—	—	—	29.9
Lime, juice	90.8	—	0.020	0.034	0.23	25.1†
Lotus root						
Raw	79.8	0	0.146	0.011	0.32	75.2
Cooked	77.8	0	0.127	0.010	0.30	72.1
Lychee, Brewster	79.0	0	0.017	0.066	0.76	83.7†
Macadamia nuts						
Raw	1.9	0	0.340	0.093	0.96	—
Roasted, whole	1.8	0	0.215	0.118	1.59	—
Malabar nightshade						
Raw	93.2	1.686	0.084	0.126	0.73	166‡
Cooked	92.4	1.836	0.081	0.133	0.70	86‡

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Mango						
Bishop	85.9	—	0.049	0.044	0.33	33‡
Common						
Green	84.0	0	0.035	0.049	0.23	61–188‡
Ripe	81.1	1.639†	0.037	0.059	0.52	70–142‡
Haden	89.5	2.530†	0.027	0.038	0.20	10.0
Joe Welch	—	2.830	—	—	—	24.4
Pirie	86.9	3.085†	0.053	0.039	0.30	15‡
Melon, Chinese preserving						
Large						
Raw	96.5	0	0.011	0.022	0.29	33.4
Cooked	95.0	0	0.010	0.015	0.32	20.2
Small						
Raw	94.6	0.012	0.067	0.023	0.32	44.3
Cooked	94.5	0.049	0.070	0.029	0.39	24.2
Milk						
Raw	87.5	—	0.024	0.178	0.08	—‡
Pasteurized	87.8	0.018 (+85.7 I.U. vit. A)	0.027	0.185	0.08	—‡
Miso—see Soybean products						
Mountain apple	91.4	0	0.029	0.036	0.24	23.4†
Mulberry, black	89.6	0.012	0.023	0.080	0.49	28.9
Ohelo berries	90.8	0.459	0.016	0.033	0.25	6‡
Okra						
Raw	89.1	0.100†	0.074	0.109§	0.88†	13‡
Cooked	88.6	0.067†	0.067	0.106§	1.02†	9‡
Onions						
Dry						
Raw	92.3	0	0.035	0.019	0.13	4.6
Cooked	90.3	0	0.041	0.019	0.14	2.3
Green						
Raw	92.8	1.664	0.078	0.113	0.60	28.4
Cooked	93.6	1.657	0.075	0.126	0.57	16.1

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Opihi (Hawaiian limpet)						
Whole	78.5	0.833 (+1004 I.U. vit. A)	0.021	0.381	1.76	0‡
Foot and mantle	78.9	0.295 (+173 I.U. vit. A)	0.028	0.103	1.43	—
Viscera	77.6	2.382 (+3394 I.U. vit. A)	trace	1.183	2.72	—
Orange, pulp, Hawaii	90.8	0.564	0.091	0.075	0.30	44.1
Papaya						
Common	87.6	—	0.039	0.030§	0.37	83.1
Solo						
Hermaphrodite	87.4	1.047	0.025	0.041	0.32	84‡
Pistillate	85.9	—	0.021	0.041	0.40	—
Passion fruit						
Purple	85.6	0.717	trace	0.131	1.46	29.8
Yellow	85.0	2.410	trace	0.101	2.24	20‡
Peas, Chinese edible pod						
Dwarf Gray Sugar						
Raw	91.5	0.313	0.175	0.076	0.74	49.5
Cooked	91.0	0.396	0.162	0.081	0.77	37.8
Mammoth Sugar						
Raw	89.9	0.287	0.142	0.082	0.71	43.2
Cooked	90.4	0.356	0.122	0.096	0.72	27.6
Pepper, green bell						
Raw	94.8	0.180	0.031	0.028	0.46	83.2
Cooked	94.6	0.195	0.030	0.026	0.43	66.0
Pigeonpea, green shelled						
Raw	68.9	0.397	0.398	0.250†	2.43	26.3
Cooked	66.2	0.380	0.412	0.226†	2.33	52.1

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Pineapple, Cayenne						
Fresh pulp	88.7	trace	0.066	0.028	0.19	7.9
Pineapple bran, dried	9.2	0.839	0.062	1.910	1.02	—
Plantains[a]						
Iholena						
Raw	69.1	0.716	0.042	0.056	0.66	12.0
Cooked	69.2	0.419	0.038	0.051	0.62	9.6
Kahili Haa						
Raw	68.6	0.492	0.043	0.058	0.79	14.6
Cooked	70.2	0.412	0.033	0.064	0.69	15.1
Moa or Huamoa						
Raw	64.5	0.114	0.048	0.050	0.76	—
Cooked	66.6	0.137	0.041	0.051	0.64	—
Popoulu						
Raw	69.1	0.675	0.057	0.067	0.63	13.8
Cooked	68.8	0.488	0.050	0.063	0.54	13.1
Puapuanui						
Raw	68.1	0.454	0.055	0.065	0.83	10.8
Cooked	70.9	0.271	0.050	0.063	0.70	10.6
Plum, Methley	87.3	0.096	0.013	0.037	0.42	trace
Poha	83.0	1.473†	0.153	0.047	1.64†	42‡
Pomelo	90.6	0	0.032	0.025	0.20	68‡
Potato, Kennebec						
Raw	83.0	0	0.102	0.022	1.30	—
Cooked	81.7	0	0.086	0.026	1.42	—
Cooking water	—	0	trace	trace	trace	—
Purslane						
Raw	91.3	1.320	0.047	0.112	0.46	21‡
Cooked	90.7	2.051	0.034	0.100	0.52	12‡
Rice						
Bran	8.3	0	2.262	0.471	49.50	—
Brown						
Raw	12.1	0	0.408	0.067	5.02	—
Cooked	73.6	0	0.121	0.020	1.34	—

[a] For definition of Plantains, see footnote on p. 35.

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Rice (*cont.*)						
Converted						
Raw	8.4	0	0.315	—	—	—
Cooked	69.8	0	0.098	—	—	—
Fortified						
Raw	10.2	0	0.998	0.038	5.89	—
Washed 5 times	12.4	0	0.464	0.032	3.98	—
Washed and cooked	59.9	0	0.200	0.014	1.70	—
Raw, 6 months storage	11.8	0	1.040	0.038	5.48	—
Partially polish						
Raw	12.5	0	0.327	0.076	4.51	—
Cooked	67.2	0	0.114	0.025	1.26	—
Roselle	91.0	0.172	0.011	0.028	0.31	12.0
Sesbania flowers, white						
Raw	89.0	0	0.083	0.081	0.43	73‡
Cooked	92.8	0	0.048	0.043	0.25	37‡
Soursop	82.2	0	0.067	0.120	1.52	16.4
Soybeans, green						
Rokusan A						
Raw	77.8	0.337	0.313	0.170	1.73	37.9
Cooked	80.5	0.383	0.210	0.124	0.99	16.6
Sac						
Raw	79.4	0.294	0.240	0.177	1.67	37.2
Cooked	81.7	0.368	0.164	0.121	1.05	16.7
Soybean products						
Aburage	53.5	0	0.048	0.032	0.28	—
Miso						
Shiro Koji	44.7	0.019	0.034	0.158	0.30	—
Shiro White	41.9	0.043	0.033	0.079	0.28	—
Special *tofu* study						
Soybean curd (*tofu*)[b]	84.1	0	0.073	0.020	0.17	—

[b] Average of 3 sets of data. See page 54 for more detail.

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Soybean products (*cont.*)						
Soybean "milk" (*tonyu*)[c]	93.0	0	0.095	0.028	0.22	—
Soybean residue (*kirazu*)[c]	80.7	0	0.100	0.024	0.19	—
Sprouts—see Bean sprouts, soy						
Spinach, Chinese (amaranth)						
Raw	92.4	1.890	0.030	0.143	0.74	24.3
Cooked	92.3	2.542	0.011	0.146	0.84	12.0
Squash						
Summer						
Pattypan						
Raw	94.8	0.078	0.082	0.084	0.76	11.8
Cooked	94.4	0.094	0.076	0.084	0.75	2.5
Zucchini						
Raw	95.3	0.166†	0.056	0.059	0.41	22.9
Cooked	93.9	0.186†	0.060	0.060	0.47	2.7
Winter-type or pumpkin[d]						
Flowers						
Raw	96.0	1.947	0.042	0.075	0.69	28‡
Cooked	96.0	4.044	0.018	0.032	0.31	5‡
Fruit						
Sample 1, yellow skin						
Raw	76.4	3.963	0.117	0.067	1.16	14.2
Cooked	75.2	5.710	0.117	0.076	1.16	7.9
Sample 2, green skin						
Raw	79.2	2.087	0.125	0.068	1.01	15‡
Cooked	79.5	2.625	0.128	0.073	1.05	14‡

[c] Average of 3 sets of data. See page 54 for more detail.

[d] The terms pumpkin and squash are often used interchangeably. It was not possible to have our samples identified botanically, as stems, leaves, and flowers were not always available.

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
Squash (*cont.*)	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g*	*mg./100 g.*	*mg. 100 g.*
Leafy tender tips						
Raw	92.6	1.942	0.094	0.128	0.93	11‡
Cooked	90.1	2.905	0.079	0.159	1.00	1‡
Strawberry	90.6	0.011	0.020	0.040	0.27	62.2
Surinam cherries	89.0	1.120	0.024	0.054	0.23	18.8
Swamp cabbage						
Raw	93.2	1.261	0.057	0.126	0.59	44‡
Cooked	92.5	2.024	0.053	0.129	0.74	10‡
Sweetpotato						
Sample 1, HSPA 3						
Raw	69.4	0.474	0.102	0.029	0.46	—
Cooked	70.8	0.323	0.091	0.034	0.44	—
Sample 2, Onolena						
Raw	72.8	4.878	0.116	0.038	0.50	21.4
Cooked	77.3	5.387	0.095	0.039	0.39	12.5
Sample 3, unnamed seedlings						
Raw	68.8	—	0.123	0.027§	0.64	—
Cooked	67.3	—	0.118	0.030§	0.58	—
Sweetpotato tops						
HSPA 3						
Raw	—	1.203	0.184	0.440	1.23	11‡
Cooked	86.6	2.958	0.150	0.336	1.24	2‡
Onolena						
Raw	—	0.941	0.132	0.297	1.06	—
Cooked	88.5	1.386	0.114	0.283	1.07	—
Tamarind						
Green	87.7	0.012	0.094	0.112	0.31	trace
Ripe	33.4	0	0.155	0.218	1.29	trace
Taro leaves (luau)						
Hawaiian (*Haokea*)						
Raw	82.5	5.688	0.230	0.464§	1.60	52‡
Cooked	83.6	5.718	0.173	0.439§	1.56	43‡

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Taro leaves (*cont.*)						
Chinese (*Bun Long*)						
Raw	80.5	3.100	0.168	0.440§	1.34	—
Cooked	81.4	3.282	0.131	0.415§	1.24	—
Taro corms						
Piko Kea						
Raw	62.6	—	0.210	0.030§	0.61	5‡
Cooked	74.3	—	0.111	0.030§	0.46	5‡
Piko Keokeo						
Cooked	74.1	—	0.090	0.029§	0.41	—
Bun Long						
Raw	58.4	—	0.174	0.026§	0.66	—
Cooked	59.6	—	0.100	0.025§	0.57	—
Poi factory study						
Taro corms, raw[e]	60.3	trace	0.222	0.040§	0.76	—
Taro corms, cooked[e]	62.3	trace	0.090	0.028§	0.60	—
Taro corms, cooked and ground (*paiai*)[e]	67.9	trace	0.080	0.029§	0.53	9‡
Taro, Japanese (dasheen)						
Raw	74.4	trace	0.065	0.018	0.64	4‡
Cooked	74.9	trace	0.047	0.016	0.60	4‡
Cooking water	—	—	—	0	trace	—
Tomatoes						
Eggshaped	—	—	—	—	—	19.8
Globe						
Kauai var.	94.4	0.422	0.054	0.027	0.57	19.1
Tree fern fronds[f]	96.7	trace	trace	0.018	trace	—
Turnip greens						
Raw	95.3	1.676	0.039	0.152	0.42	42.8
Cooked	93.8	2.850	0.042	0.134	0.52	42.3

[e] Average of 3 sets of data, except for carotene values (1 set only). See page 55 for more detail.

[f] Cooked (p. 89).

TABLE 1 (*Continued*). Carotene, thiamine, riboflavin, niacin, and ascorbic acid values of foods in Hawaii (per 100 grams of edible food).

FOOD*	MOISTURE	CAROTENE	THIAMINE	RIBO-FLAVIN	NIACIN	ASCORBIC ACID
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Vi-apple	85.9	0.360†	0.052	0.015	1.33	50.6†
Watercress						
Raw	94.6	1.197†	0.077	0.130	0.47	56‡
Cooked	94.1	1.642†	0.068	0.144	0.50	51‡
Watermelon	91.0	0.426	0.035	0.037	0.18	6‡
Yam bean root						
Raw	88.6	0	0.077	0.061	0.26	11.6
Cooked	88.6	0	0.081	0.062	0.21	8.7
Yam, Polynesian						
Raw	90.6	—	0.036	0.018	0.33	trace
Cooked	86.8	—	0.035	0.018	0.26	2.8

* Except where stated specifically, vitamin values were determined on the food sample in the raw or natural state, i.e. avocado.

† Moisture content not determined, but assumed to be similar to value given in first column.

‡ Values (ascorbic acid) taken from TB 6.

§ Determined microbiologically.

Note: *Trace* indicates that values were less than 0.010 mg. for carotene, thiamine, and riboflavin; 0.10 mg. for niacin; 1 mg. for ascorbic acid. 0 in the carotene column indicates that in the absence of any yellow pigment it was assumed that no carotene was present. — indicates that no determinations have been made.

The vitamin A value of the foods assayed followed the usual pattern—thin green leaves and deep-yellow foods showing the highest values. Among leafy vegetables the best sources (over 2.5 milligrams carotene per 100 grams) were leaflets and tender tips of the horseradish tree, jute, and taro leaves (Chinese and Hawaiian). The carotene contents of other parts of the plants were generally much lower. Among yellow fruits and vegetables, good sources were three varieties of mangos (Haden, Joe Welch, and Pirie) and a winter-type yellow squash. Most roots and tubers have low vitamin A values except carrots and deep-yellow sweetpotatoes. In general, the vitamin A value was proportional to the intensity of the yellow or green color of the food. Foods that showed no evidence of color, such as daikon, lychee, or coconut, were not assayed but were assumed to contain no provitamin A. Values for these foods are indicated by 0 in table 1. The viscera of the opihi was an excellent source of carotene and vitamin A.

In general, the literature indicates that the vitamin A value is not greatly altered by ordinary cooking processes, although some investigators have found more carotene in the cooked product than in the raw (*36, 41*). Out of 70 foods, 17 leafy vegetables (beet greens, belembe, bittermelon leafy tender tips, green mustard cabbage, white mustard cabbage, cowpea tender tips, horseradish tree leaflets and tender tips, jute, purslane, Chinese spinach, swamp cabbage, sweetpotato tops [two varieties], taro leaves [two varieties], turnip greens, and watercress) and 8 other vegetables (asparagus, broccoli, carrots, cowpea pods, winter squash [two varieties], winter squash flowers, and sweetpotatoes) were found to show an increase in carotene content of over 0.250 milligram per 100 grams when cooked (compared on the same moisture basis, p. 11). The Iholena cooking banana showed an apparent loss of over 0.250 milligram. Forty-four foods showed no nutritionally significant change.

Using the conversion factor of 1 microgram of carotenoid pigments equivalent to 1 International Unit, the vitamin A values of 76 foods were compared with those given in AH 8 and AH 34. Values varying by more than 250 International Units per 100-gram sample were considered to be significantly different nutritionally.

For 39 foods, the Hawaii values were lower than the published ones. This may be explained partly by the lower microgram to International Units conversion factor used in this laboratory, and partly by such factors as environment, variety, storage, and transportation. Passion fruit (yellow and purple), pigeonpeas, and poha were locally grown foods with vitamin A values higher than published figures. Thirty-three foods had values considered to be the same (within 250 International Units per 100 grams). Additional comparisons were made with published data for carotene for 52 Central American foods (*29*). Only 3 out of 52 foods (broccoli, hyacinth beans, and turnip greens) had lower values, indicating good agreement with their values.

Thiamine

Thiamine is widely distributed in plant foods but only a few, such as unmilled cereal grains, mature dry legumes, and nuts, can be classified as rich sources of thiamine.

Among the foods assayed, the following were considered good sources (over 0.2 milligram thiamine per 100 grams of food): asparagus, lima beans, fresh seeds and leafy tender tips of cowpeas, egg yolk, goa beans, horseradish tree leaflets and tender tips, raw and roasted macadamia nuts, pigeonpeas, rice (brown, converted, fortified, and partially polished), rice bran, green soybeans, taro leaves (Hawaiian), and bran-salt-pickled daikon. Most of these can make a worthwhile contribution to the diet when eaten in the usual amounts, but some, like the leaflets and tender tips of cowpeas and of the horseradish tree, are so light in weight that the quantity required to make 100 grams is more than would be consumed as an average serving. Rice bran is not normally eaten as such.

On the other hand, some foods like breadfruit, fresh green corn, potatoes, sweetpotatoes, and taro, which after cooking contain about 0.10 milligram per 100 grams may make an important contribution to the diet, especially when they constitute the staple foods and are eaten two or three times a day (see p. 31 for full discussion).

It was assumed that green soybeans, a favored food of the Oriental people, prepared by cooking them in the pods in boiling salted water would retain most of their original thiamine content, but beans cooked in this manner were found to have lost almost one-third of the original thiamine content (*27*). To check the results originally obtained by the rat-growth method and to determine if it is possible to minimize the loss, three cooking procedures were compared to determine which method or methods retained maximum amounts of thiamine, riboflavin, and niacin. Details of this special study may be found on page 51.

Although it is well known that rice polish and rice bran are potent sources of the B vitamins, work from this Station was the first to show that when vegetables are salt-pickled with rice bran in the Oriental manner, they adsorb thiamine from the rice bran (*20*). The quantity of thiamine adsorbed appears to depend upon the amount and kind of vegetable surface exposed. Details of this study may be found on page 50.

The extensive and widespread use of rice in Hawaii makes its nutritive value of great importance. Of three kinds of rice assayed, the thiamine content of brown and converted rice compared favorably with published values, and the fortified rice contained more than twice the minimum value printed on the package. Washing and cooking appeared to affect the thiamine content very little in brown and converted rice, 1 percent and 6 percent loss on dry weight basis, but in enriched rice, washing five times caused a 52 percent loss and cooking an additional 3 percent loss. This loss could be minimized by fewer washings. Storage for 6 months in a tight metal container in the laboratory appeared not to affect the thiamine content of the fortified rice.

Macadamia nuts, produced commercially in Hawaii, are comparable to peanuts in thiamine content.

It has been established that thiamine is easily lost during food preparation because it is highly water soluble and unstable when heated in neutral solutions. The cooking method employed favored the retention of thiamine as, with few exceptions, the vegetables were steamed (see p. 9) and the residual liquid utilized. Out of 88 cooked samples, 16 showed nutritionally insignificant vitamin losses between 0.02 and 0.08 milligram per 100 grams raw sample (see p. 11 for method of calculation and comparison). The greatest loss of 0.550 milligram per 100 grams occurred with the enriched rice sample which had been washed five times and then cooked.

The thiamine values for 106 raw foods appearing in table 1 were compared with figures given in AH 8 and AH 34. Only those values varying by more than 0.08 milligram per 100-gram sample were considered to be significantly different nutritionally.

Six foods had higher than published values: hyacinth beans; lotus root; brown, converted, and fortified rice; and taro corms (average of three samples). Chinese edible pod peas (two varieties), green soybeans (Sac), and ripe tamarind were foods with lower than published figures. Considering the probable differences in variety, growing conditions, and assay techniques, our results and the published figures agree well.

Foods Rich in Carbohydrates as Sources of the B Vitamins. Foods such as breadfruit, sweet corn, potatoes, sweetpotatoes, taro, and poi, which on the weight basis appear to be less good sources of thiamine than enriched cereals (bread and rice), are as good or better sources when compared on the basis of isocaloric quantities as shown in table 2. They are, of course, much better than these two highly milled cereals when not enriched. The same comparison holds true for niacin and, for some of the foods, for riboflavin. (All comparisons based on the values for cooked foods.)

People who depend upon breadfruit, potatoes, sweetpotatoes, and/or taro for their basic foodstuffs obtain adequate quantities of thiamine from these sources but would be certain to fall short of the needed quota when these are replaced with unenriched highly milled cereals.

Riboflavin

On the whole, fruits and vegetables, when compared to some other classes of foods (i.e., liver 2.0 to 4.0 milligrams, cheese 0.5 to 1.0 milligram, and eggs 0.3 to 0.5 milligram per 100 grams), are relatively poor sources of riboflavin. But the dark-green leafy vegetables contain more than other vegetables and fruits (*38*).

Many of the island vegetables analyzed contained less than 0.160 milligram per 100 grams, but some had larger amounts (from 0.160 to 0.660 milligram per 100 grams), namely, asparagus, beet greens, belembe, bittermelon leafy tender tips, broccoli, cowpea tender tips, horseradish tree leaflets and tender tips, jute, green shelled pigeonpeas, green soybeans, sweetpotato tops, and taro leaves.

Few of the island fruits contained more than 0.050 milligram per 100 grams,

TABLE 2. Comparative amounts of the B vitamins—thiamine, riboflavin, and niacin—furnished by isocaloric quantities of some foods high in carbohydrate.*

COOKED FOODS	WEIGHT FOR 200 CALORIES	THIAMINE	RIBOFLAVIN	NIACIN
	g.	*mg.*	*mg.*	*mg.*
Bread, white, unenriched	73	0.04	0.08	0.7
Bread, white, enriched	73	.18	.11	1.6
Breadfruit, mature green	160	.20	.09	1.1
Breadfruit, ripe	168	.18	.09	2.2
Corn, sweet	235	.36	.30	4.9
Potato	241	.21	.06	3.4
Sweetpotato	163	.16	.06	0.6
Taro (*Piko Kea*)	153	.17	.05	0.7
Taro, Japanese (dasheen)	274	.13	.04	1.6
Taro, *paiai*	167	.13	.05	0.9
Rice, brown (unpolished)	165	.20	.03	2.2
Rice, partially polished	160	.18	.04	2.0
Rice, converted	160	.16	.03	2.6
Rice, enriched	127	.25	0.02	2.2
Rice, white	127	0.02	—	0.1

* Original vitamin data from table 1, except those for bread and several for rice.

an amount less than one-twentieth of the RDA as stated previously (p. 11). However, some of the fruits, i.e., most varieties of avocado, passion fruit, soursop, and tamarind, ranged from 0.101 milligram to 0.218 milligram riboflavin per 100 grams.

The riboflavin content of roasted macadamia nuts (0.118 milligram per 100 grams) is comparable to those of other nuts (cashews, peanuts, pecans, and walnuts).

Analysis of island-produced milk showed the riboflavin content to compare favorably with mainland pasteurized milk; and the values obtained for island eggs were somewhat greater than the typical values published in AH 8 and AH 34 (*40, 17*). Opihi (Hawaii limpet) is a good source of riboflavin, containing 0.381 milligram per 100 grams, somewhat higher than related types of seafoods. The major portion of the vitamin is concentrated in the viscera.

As a result of cooking 87 foods, 14 appeared to increase in riboflavin content to the extent of 10 percent or more, whereas 33 foods appeared to decrease 10 percent or more (see p. 11 for method of calculation and comparison). However, none of the gains and losses were greater than 0.08 milligram per 100 grams, which we have arbitrarily chosen as a significant nutritional difference. In fact, 49 of the samples contained 0.08 milligram or less per 100 grams in the raw state, so that even if the losses were 30 percent or more for these poor sources of riboflavin, it could scarcely be considered of importance nutritionally.

When the riboflavin values for the island foods were compared with AH 8 and AH 34 on the basis of the arbitrary scale previously described (see p. 11) only 4 out of 102 foods (raw figures only) varied more than ±0.08 milligram per 100 grams. Two were higher (whole egg and egg white), and two were lower (white mustard cabbage and turnip greens) than the USDA figures.

Niacin

The niacin content of fruits and vegetables, in general, parallels that of the riboflavin content of these classes of foods. Most of the island fruits and vegetables assayed contained less than 1.60 milligrams per 100 grams. But 14 contained 1.60 milligrams or more per 100 grams; namely, some varieties of avocado, green lima beans, corn, fresh cowpea seeds, horseradish tree leaflets and tender tips, passion fruit, green shelled pigeonpeas, poha, green soybeans, taro leaves, and two vegetables pickled in salt and rice bran (white mustard cabbage and daikon). Roasted macadamia nuts most resemble walnuts in their niacin content.

Opihi had 1.76 milligrams of niacin per 100 grams for the whole shellfish, but separate analyses of foot and viscera showed that most of the niacin, like the riboflavin, is in the viscera.

Of the 87 foods cooked in the laboratory, 10 showed an apparent increase of 10 percent or more, and 34 foods showed a decrease of 10 percent or more in their niacin content (see p. 11 for method of calculation and comparison). As with riboflavin, the differences were not nutritionally significant with two exceptions, fortified and partially polished rice.

Cooked fortified rice showed a loss of 35 percent amounting to 2.08 milligrams niacin per 100 grams (on the raw basis). Most of this reduction in vitamin value occurred as a result of the washing process (see p. 83), since the washed rice samples showed a 31 percent loss of niacin when recalculated in the same manner as the cooked rice. For the cooked partially polished rice, the loss was 25 percent or 1.15 milligrams niacin per 100 grams. In comparison, brown rice showed only an 11 percent loss, or 0.56 milligram, an amount less than the arbitrary 0.8 milligram limit. The partially polished and brown rice were cooked in the same manner, following one washing, but the white fortified rice was washed five times before cooking as is the general custom in Oriental homes (see p. 83).

With the exception of two foods (pohas, less; and fresh cowpea seeds, greater), all the niacin values for island foods were within ±0.8 milligram per 100 grams of those reported in AH 8 and AH 34 and are therefore considered to be similar to typical values.

Ascorbic Acid

Analyses of island fruits showed many of them to be excellent sources of ascorbic acid (carissa, common guava, ketambilla, lychee, some varieties of mango, oranges, papaya, poha, pomelo, strawberries, and vi-apple), and superior to mainland citrus fruits distinctive for their ascorbic acid content.

Some exceptionally good sources of ascorbic acid can be found among the island-grown vegetables; belembe, broccoli, horseradish tree leaflets and tender tips and pods, and malabar nightshade, all contain 90 milligrams or more per 100 grams in the raw state. Other excellent sources are bittermelon fruit and leafy tender tips, green mustard cabbage, head cabbage, cauliflower, lotus root, Chinese preserving melon (small), edible pod peas, green bell pepper, sesbania flowers, swamp cabbage, taro leaves, turnip greens, and watercress, all ranging from 40 to 75 milligrams per 100 grams. Of all the raw foods analyzed for ascorbic acid, only eight contained 4 milligrams or less per 100 grams.

Most vegetables are cooked before eating, although some are eaten both raw and cooked. In this study, the vegetables were cooked by steaming, with a few exceptions (see p. 9), to minimize vitamin losses due to water leaching. Nevertheless, of the 52 cooked foods, 45 lost 10 percent or more, 41 lost 20 percent or more, and 13 lost 50 percent or more of their ascorbic acid. (This count does not include values taken from TB 6.) Those foods which lost 20 percent or more lost more than 4 milligrams per 100 grams, which we consider nutritionally significant. However, in some instances the original content of ascorbic acid was less than 4 milligrams per 100 grams (e.g., eggplant) and a large percentage loss would not be significant. Since cooking losses are greater than for other vitamins, great care must be exercised to protect and preserve the ascorbic acid.

When the ascorbic acid figures for the island foods were compared with AH 8 and AH 34 on the basis of the arbitrary scale previously described (see p. 11) more than 50 percent varied significantly. Thirty-six island-grown products (25 vegetables and 11 fruits) had lower values, and 19 (13 vegetables and 6 fruits) had higher values. Since most of the samples analyzed were obtained at the local markets, methods of handling, storing, transporting, and marketing, all of which affect ascorbic acid content (*39*), were variable. These may have been important factors which contributed to the low values for vegetables in spite of the attempt always to obtain good fresh quality produce.

SPECIAL STUDIES

Fruits

Effect of Variety Upon Vitamin Content of Fruits. There is considerable evidence to show that the ascorbic acid content of tropical fruits differs greatly with variety, as may be seen in tables 3 and 10, although it is recognized that there are other factors which contribute to these variations (*38*). The results of additional assays shown in table 1 indicate variations not only in

TABLE 3. Effect of variety upon the ascorbic acid content of fruits.*

NAME AND VARIETY	ASCORBIC ACID	NAME AND VARIETY	ASCORBIC ACID
	mg./100 g.		*mg./100 g.*
Avocado		Guava	
West Indian race		Common, ripe (100 samples)	70–350
Purple rind		Cattley	
No. 1	5	Red	33
No. 2	12	Yellow	53
Green rind		Lime (juice)	
No. 1	5	Barss	24
No. 2	9	Kusaie	19
No. 3	16	Lakeland	30
No. 4	15	Rangpur	10
Guatemalan		Mango (ripe), see table 10	
No. 1	8		
Banana			
Bluefields	6		
Brazilian	16		
Chinese	8		
Ice Cream	19		
Popoulu Kaio (cooking banana)	15		

* Data from TB 6.

ascorbic acid but also in the three B vitamins and carotene for different varieties of avocados and bananas.

As previously stated (see p. 11), if 100 grams (an average serving of many foods) show a value less than one-twentieth of the RDA, it is not an important or significant source of the vitamin from the standpoint of practical nutrition. On this basis, avocados are not nutritionally important sources of thiamine; bananas and plantains[1] are not important sources of thiamine, riboflavin, and niacin; and bananas are not important sources of carotene but some of the plantains are.

[1] In this bulletin, the term "banana" is used only for those varieties that are commonly eaten raw (*Musa paradisiaca*, var. *sapientum*). The term "plantain" is used to designate the varieties of bananas that are most palatable when cooked, even though some may be edible in the raw state. They are commonly called "cooking bananas" in Hawaii and are designated botanically as *Musa paradisiaca* subspecies *normalis*.

To effect a more satisfactory comparison of the vitamin values, they were all recalculated to the same moisture basis of 70 percent (30 percent solids), and the figures inspected to note if many of the differences were greater than one-twentieth of the RDA (see p. 35). When comparisons were made in this manner, the variations between some of the values great enough to be considered true differences nutritionally were as follows: carotene, riboflavin, niacin, and ascorbic acid for some types of avocados; ascorbic acid for bananas.

A larger study would be required to demonstrate clearly the variations or lack of variations suggested by this preliminary work, but it seems obvious that for the fruits and the vitamins studied, ascorbic acid is likely to show the greatest variation among varieties.

Changes in the Ascorbic Acid Content of Fruit During Ripening. Data reported in TB 6 showed that when mangos were tested for their ascorbic acid values, the degree of ripeness affected the quantity of vitamin present. Data for the ascorbic acid of 14 varieties at two or at three stages of ripeness are given in table 4. As the samples in each case consisted of sections from four to six mangos from the same tree, the values are considered to be true differences resulting from the stage of ripeness and not differences in individual mangos. In every instance the quantity of ascorbic acid decreased as the mangos ripened.

Unlike mangos, papayas and pohas show an increase of ascorbic acid as the fruit ripens, as indicated by the data in table 4.

Ascorbic Acid Analysis of Fruit Juices and Nectars Processed in the Islands. The purpose of this study was (1) to determine the ascorbic acid content of locally processed Hawaii fruit juices and nectars as purchased in the markets, (2) to learn whether a variation existed attributable to brand or to the store where purchased, and (3) to study the stability of the ascorbic acid in "bottled" nectars under home refrigeration.

Actually all the available products studied except one, lilikoi (purple passion fruit) juice, were nectars. According to the regulations of the Pure Food and Drug Act, nectars are an undefined product and the contents must be clearly stated on the can, whereas juice, such as orange and pineapple, is a defined product.

The number of locally canned fruit juices or nectars (other than pineapple juice) was limited in 1952. Products of only three companies were found in Honolulu markets. Two brands offered the same three types of nectars—papaya, papaya–pineapple, and guava. One of these brands was generally carried in all the stores, while the other was found in only one of the stores checked. Lilikoi juice, manufactured by the third company, was also found in only one store.

All brands and varieties of the above-listed nectars and juice offered in four typical stores in Honolulu (two supermarkets, one moderate-size store and one small one) were purchased within a month's time. According to the directions

TABLE 4. Changes in ascorbic acid content of fruit during ripening.*

FRUIT	VERY GREEN	GREEN	HALF-RIPE	RIPE
	mg./100 g.	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Mango:				
Cigar	—	—	154	119
Common (Manini)	—	188	145	114
Fairchild	—	—	31	19
Haden	—	42	—	14
Indian race	—	—	61	56
Itamaracca	—	—	53	40
Number 9	—	43	37	30
Philippine type	—	—	25	15
Pirie	—	60	50	14
Pirie seedling	—	—	60	28
Sandersha	—	—	33	26
Smith-Wootten	—	—	105	79
Strawberry	—	42	—	24
Wootten	—	103	—	63
Papaya:				
Series 1 (large-fruited type)	32	40	53	68
Series 2 (Solo variety)	31	72	95	102
Poha	—	31	36	42

* Data from TB 6.

on the can, the lilikoi juice was to be diluted for serving, but the nectars were to be served as processed. Undiluted duplicate samples from one can or bottle of each product were analyzed for their reduced ascorbic acid content.

When the second survey of the products was conducted two years later (1954), three additional brands manufacturing canned guava nectar, a fourth producing "bottled" guava nectar (vitamin C added), and a fifth supplying "bottled" guava nectar and papaya nectar were found on the market. The "bottled" nectars, presumably made of fresh or frozen puree, were sold in quart milk bottles, or in wax-lined cardboard cartons, both kept under refrigeration at the markets. All brands available in four food stores were purchased and the ascorbic acid was determined in the same manner as in 1952. The "bottled" nectars were obtained from six markets (two supermarkets, two moderate-size and two small stores).

The results given in tables 5 and 6 show the ascorbic acid values of these processed nectars and juices to be low and variable, especially when compared with the values for the fresh fruits in table 1. Many factors other than the orig-

TABLE 5.

Ascorbic acid content of commercially canned Hawaii fruit juices and nectars from different-size stores in Honolulu.

(Expressed as milligrams per 100 grams.)

SAMPLE	SUPERMARKET		SUPERMARKET		MODERATE SIZE		SMALL SIZE		RANGE
Series →	*1952*	*1954*	*1952*	*1954*	*1952*	*1954*	*1952*	*1954*	
Brand I									
Guava Nectar	7.9	1.3	2.4	17.0	5.9	2.3	13.4	10.8	1.3–17.0
Papaya Nectar	10.4	16.8	15.9	17.6	15.9	5.9	6.5	14.5	5.9–17.6
Papaya–Pineapple Nectar	14.7	3.8	9.4	9.8	14.6	6.4	7.8	13.7	3.8–14.7
Brand II									
Guava Nectar	—	—	7.9	—	—	—	—	—	
Papaya Nectar	—	—	9.6	—	—	—	—	—	
Papaya–Pineapple Nectar	—	—	7.6	—	—	—	—	—	
Brand III									
Lilikoi (purple passion fruit) juice									
As purchased	—	6.3	—	—	18.8	—	—	—	6.3–18.8
As served*	—	0.4	—	—	1.2	—	—	—	0.4–1.2
Brand IV									
Guava Nectar	—	7.8	—	—	—	—	—	—	
Brand V									
Guava Nectar	—	16.0	—	15.9	—	—	—	—	15.9–16.0
Brand VI									
Guava Nectar	—	15.6	—	—	—	—	—	—	

* Directions on label: 1 cup juice, 14 cups water.

inal ascorbic acid content of the fruit may contribute to this variability, i.e., treatment prior to processing, processing procedures including dilution with water, and length and temperature of storage.

The "bottled" guava nectars on the whole were somewhat better sources of ascorbic acid than the canned products, though still much lower than the fresh fruits. The range of ascorbic acid values for canned guava nectar was 1.3 to 17.0 milligrams per 100 grams and for the "bottled" nectars from 0.3 to 26.2 milligrams per 100 grams compared with 70 to 125 milligrams per 100 grams for fresh fruit. (We have tested wild guavas that assayed 350 milligrams ascorbic acid per 100 grams.) Brand A (table 6) contained added ascorbic acid according to the label, but the quantity added was not stated.

There appeared to be no relationship between vitamin content and origin of purchase, but with respect to brand, the glass-bottled Brand A with added vitamin C showed the least variation.

When these canned and "bottled" juices and nectars were obtained from the various stores, it was not ascertained how long they had been on the shelves, but since the consumer would be purchasing under the same conditions, they are typical of what he could buy. The consumer should be made aware of the difference in the nutritive value (ascorbic acid content) of the fresh products and the processed ones now available (1954), and also what vitamin C content it is reasonable to expect in good quality canned or "bottled" nectars.

Since there are no defined limits for the water content of nectars, and because guava is a strong-flavored fruit, the tendency has been to greatly dilute

TABLE 6. Ascorbic acid content of commercially "bottled" Hawaii fruit nectars from different-size stores in Honolulu.

(Expressed as milligrams per 100 grams.)

STORE SIZE	GUAVA NECTAR		PAPAYA NECTAR
	Brand A (vit. C added) glass bottles	Brand B waxed cartons	Brand B glass bottles
Supermarkets			
1	14.9	11.2	16.2
2	25.4	12.7	18.8
Moderate-size stores			
1	26.2	0.3	—
2	—	14.3	—
Small-size stores			
1	22.5	7.2	15.9
2	25.2	8.6	12.6
Range	14.9–26.2	0.3–14.3	12.6–18.8

the products. If artificial color and acid are used as well as added vitamin C, the product becomes more nearly a synthetic than a natural one.

The University Food Processing Laboratory has evolved, through some years of experimentation, methods of preparing high quality fruit nectars made from local fruits. But until the producers follow these recommendations and are able to utilize guavas with an initial high ascorbic acid content, the consumer cannot rely upon commercial guava nectars as a good source of ascorbic acid.

The wide range in ascorbic acid content of the various products examined to April 1955, indicates that they are undependable sources of this vitamin. The work also confirms the need for establishing standards for processed Hawaii fruit juices and nectars which was pointed out almost 10 years ago (*27*).

In addition to assays made on the day of purchase, the vitamin content of "bottled" nectars was determined after 1 week of refrigerated storage at 40° F. The results are presented in table 7 along with data on the pH values, water content, and the percentage loss in vitamin value. Although the acidity of the nectars was high (pH 2.7 to 3.2) the loss of ascorbic acid was rapid and great, more so than that of home-prepared juices refrigerated in unsealed containers (see table 9). Thus, these products should be consumed quickly after opening and should not be stored even a week.

Guava nectar packaged in waxed cartons showed a greater percentage loss of ascorbic acid upon refrigerated storage than did nectar in bottles. To ascertain whether this was due to the type of container or to other factors, the two brands were stored in each of two types of containers. Brand A showed a 24 percent loss of ascorbic acid after 1 week of refrigerated storage in a glass bottle (control) and 30 percent in a waxed carton. Brand B had 47 percent loss in the waxed carton (control) and 40 percent in the glass bottle. The container effects were smaller than the brand effects. The latter appears large on a percentage basis because Brand B had much less ascorbic acid than Brand A although the loss in milligrams was comparable for both.

Ascorbic Acid Content of Guavas.

Distribution in rind and pulp. The thick rind portion of the common guava contains more ascorbic acid than the pulp and seeds, both because there is a greater proportion of the rind than pulp in each guava, and because per unit of weight the rind is richer in ascorbic acid, according to work previously published from this laboratory (*27*). Recent work on two samples of guavas (6 and 12 guavas making up the two samples) confirms these earlier studies that the proportion of ascorbic acid in the pulp and rind is roughly 30 percent and 70 percent respectively.

Stability at room temperature. The stability of the ascorbic acid in cut guavas exposed to room temperature was tested at three different times using freshly picked guavas (6, 12, and 13 guavas making up the three samples). Each time the guavas were quartered to make four subsamples. One quarter

TABLE 7. Effect of refrigerated storage on the ascorbic acid content of "bottled" nectars.

SOURCE, BRAND OF NECTAR, TYPE OF BOTTLING	WATER	pH	ASCORBIC ACID day of purchase	After 1 Week Refrigerated Storage retained	loss
	%		mg./100 g.	mg./100 g.	%
Supermarket 1					
Brand A guava (vit. C added), glass bottles	87.3	3.1	14.9	9.0	40
Brand B guava, waxed cartons	88.9	3.1	11.2	3.3	71
Brand B papaya, glass bottles	89.8	4.4	16.2	12.2	25
Supermarket 2					
Brand A guava	87.5	3.1	25.4	17.5	31
Brand B guava	88.6	3.2	12.7	6.1	52
Brand B papaya	89.4	4.3	18.8	14.1	25
Moderate-size store 1					
Brand A guava	87.8	3.1	26.2	25.6	2
Brand B guava	88.5	3.1	0.3	0.2	—
Moderate-size store 2					
Brand B guava	88.6	3.2	14.3	7.2	50
Small-size store 1					
Brand A guava	87.5	2.7	22.5	17.6	22
Brand B guava	88.5	2.9	7.2	2.7	62
Brand B papaya	89.2	4.2	15.9	13.8	13
Small-size store 2					
Brand A guava	87.4	2.9	25.2	16.4	35
Brand B guava	88.3	3.1	8.6	2.1	75
Brand B papaya	89.5	4.2	12.6	9.3	26
Range of values					
Brand A guava	87.3–87.8	2.7–3.1	14.9–26.2	9.0–25.6	2–40
Brand B guava	88.3–88.9	2.9–3.2	0.3–14.3	0.2– 6.1	50–75
Brand B papaya	89.2–89.8	4.2–4.4	12.6–18.8	9.3–14.1	13–26

from each fruit was pooled to form the sample for immediate analysis by combining with acid in a Waring blendor (see p. 11). The second lot of quarters was placed on and covered with glass or wax paper in a well-lighted laboratory at room temperature (83° to 84° F.) for 3½ hours. The third lot was cut into small pieces (quarters cut lengthwise in half and crosswise in fourths) and kept as above, and for the fourth lot the quarters were finely chopped, mixed, and kept as above. At the end of 3½ hours, reduced ascorbic acid was determined on these subsamples with the following results:

SAMPLE AND TREATMENT	SERIES I		SERIES II		SERIES III	
	Ascorbic Acid	Loss	Ascorbic Acid	Loss	Ascorbic Acid	Loss
	mg./100 g.	*%*	*mg./100 g.*	*%*	*mg./100 g.*	*%*
Fresh guava quarters	111	—	109.6	—	92.3	—
Quarters, 3½ hours	109.6*	1	107.3	2	93.2	0
Small pieces, 3½ hours	—	—	104.0	5	87.9	5
Chopped finely, 3½ hours	—	—	—	—	65.4	29

* 4½ hours.

Work reported on the stability of ascorbic acid in TB 6 showed that when guavas were finely chopped, the vitamin losses were fairly large (averaging 29 percent). In this experiment the guava quarters and small pieces lost little of their ascorbic acid content in the 3½-hour period, but the finely chopped subsample lost 29 percent. When guavas are finely chopped or mashed, a large surface area is exposed to oxidation and the enzymes are freed from the cells, both of which appear to favor destruction of the vitamin. Since about one-third of the vitamin may be lost when the guavas are finely chopped or mashed, rapid handling is advisable to preserve maximum ascorbic acid values.

Ascorbic acid content of juice and the remaining pulp. The amount of ascorbic acid in guava juice prepared from raw and from cooked guavas was determined, as well as that remaining in the waste pulp and that lost in preparation. Two series of tests were run on different days, using different lots of guavas (14 and 15 fruit, respectively). Guava juice as prepared here and as usually available is not a true juice but a watery extract of the fruit.

The guavas were cut in half lengthwise to form two subsamples, A and B. Thin lengthwise slices from each guava made up the sample used for determining the ascorbic acid content of the fresh product. Subsample A was sliced, put in a large glass beaker, and enough distilled water added to barely cover the guavas (1¼ parts guava to 1 part water). This mixture was gently boiled uncovered for 10 minutes, stirring occasionally with a glass rod, cooled slightly, and brought back to the original precooked weight by the addition of distilled water. It was then strained immediately through two thicknesses of flour sack, previously dampened with distilled water, to prevent excess absorption of

TABLE 8. Retention of ascorbic acid in cooked and raw guava juice.

ITEM	SERIES I				SERIES II			
	Sample Total Wt.	ASCORBIC ACID			Sample Total Wt.	ASCORBIC ACID		
	g.	*mg./100 g.*	*total mg.*	%	*g.*	*mg./100 g.*	*total mg.*	%
Cooked:								
Fresh guava (original total)	484	125.9	609.4	100	417	116.5	485.8	100
Cooked guava and water	872	65.0	566.8	93	752	63.3	476.0	98
Waste cooked pulp	110	37.5	41.2	7	97	35.8	34.7	7
Cooked juice	762	68.3	520.4	85	626	66.4	415.7	86
Loss in preparing	—	—	—	8	—	—	—	7
Raw:								
Fresh guava (original total)	505	125.9	635.8	100	401	116.5	467.2	100
Raw guava and water	907	64.6	585.9	92	723	57.1	412.8	88
Waste raw pulp	263	12.3	32.4	5	102	9.5	9.7	2
Raw juice	634	61.9	392.4	62	598	55.8	333.7	71
Loss in preparing	—	—	—	33	—	—	—	27

liquid, and as much juice as possible was squeezed through the sack (*21*).

Subsample B was sliced and blended for 1½ minutes in a Waring blendor with the same proportion of water as used for the cooked product above. This was strained through two thicknesses of flour sack as above.

Reduced ascorbic acid was determined on the fresh guava slices, the cooked guava mixture, the cooked waste pulp, the cooked juice, the raw guava and water blend, the raw waste pulp, and the raw juice. The results are shown in table 8. The seeds were not removed but they did not crack in the blending procedure.

Cold extraction of raw juice resulted in obtaining an average of only 67 percent of the ascorbic acid in the guavas, whereas by cooking the guavas with water and pressing out the juice, 85 percent of the ascorbic acid was extracted. The ascorbic acid contents of both waste pulps were low, 3 and 7 percent; but the loss in preparation of the raw juice was approximately four times that of the cooked juice, about 30 percent for raw and 8 percent for cooked. The greater percentage loss in preparation of the raw juice could in part be caused by enzymes not inactivated by heat (*15*).

Ascorbic acid content of raw and cooked juice before and after refrigerated storage. The cooked and raw guava juices prepared as described in the preceding section were stored refrigerated at 40° F. for a period of 2 or 3 weeks and samples were removed at weekly intervals for ascorbic acid assays (see table 9).

The losses of ascorbic acid for cooked and raw guava juices were comparable, and followed the same trend as a study previously reported in TB 6. Though the general appearance of the juices did not change, and the acidity was high (pH 2.5 for raw and 2.6 for cooked), the ascorbic acid content dropped rapidly. Judging from these results, storage of unsealed guava juice

TABLE 9. Effect of refrigerated storage on the ascorbic acid content of guava juices.

Juice	Series I		Series II	
	Ascorbic Acid	Loss	Ascorbic Acid	Loss
	mg./100 g.	%	*mg./100 g.*	%
Cooked juice:				
Immediate	—	—	66.4	—
1 week	68.3	11	55.8	16
2 weeks	60.9	27	—	—
3 weeks	49.7	—	38.1	43
Raw juice:				
Immediate	61.9	—	55.8	—
1 week	53.4	14	45.0	19
2 weeks	43.7	30	39.2	30
3 weeks	—	—	30.2	46

in the refrigerator longer than 1 week is inadvisable, especially if the juice is used as the principal source of ascorbic acid for infants and small children.

Orr and Miller reported that frozen guava juices and purees even after 52 weeks storage at 0° F. retained approximately 75 to 90 percent of the ascorbic acid present (*34*). In this work the preparation of the juices was somewhat different than that described above.

Ascorbic Acid Content of Mangos.

Differences in ascorbic acid content among ripe varieties. Evidence that mango varieties exhibit a wide range of ascorbic acid values is given in table 10. Ripe mangos may have as little as 5 milligrams per 100 grams or as much as 142 milligrams, according to our studies.

The figures in table 10 also indicate some marked variations in the same variety from different sources and different seasons (see Common, Holt, and Wootten). While others, like the Pirie and Brooks Late, yielded values within a rather narrow range.

It would require an extensive project to determine all the factors that influence the ascorbic acid of mangos but since the consumer looks to fruit to furnish the needed quantity of this vitamin, any selection or breeding program should consider the ascorbic acid content of the mangos as well as desirable qualities from the standpoint of the horticulturist and the processor.

To learn how great the variation appeared to be among mangos of uniform quality obtained from the same area in the same season, the special study which follows was made on two varieties.

Differences in ascorbic acid content among fruits of the same variety. In order to show possible variations in ascorbic acid content from mango to mango of the same variety, 10 Haden mangos (grown at the Station Experimental Farm at Poamoho), and, at another season, 10 mangos of the Joe Welch variety (grown in the Hawaiian Sugar Planters' Association Experiment Station plots on Molokai) were compared. The mangos were firm ripe and of fine quality.

Each sample, consisting of the total flesh of one mango, was blended for about 1 minute in the Waring blendor to make a homogeneous puree. From this, 100 grams were quickly weighed and reblended with 100 milliliters 6 percent metaphosphoric acid. This same procedure was carried out for each mango. The reduced ascorbic acid content was determined from these 1:1 blends as described under Methods. Table 11 gives the weights of the individual mangos and the ascorbic acid and pH values obtained for both varieties. The pH was measured on a blend of two fruits for the Haden varieties and individually on the puree of each of the Joe Welch mangos.

The ascorbic acid of the ripe Haden mangos ranged from 7.3 to 13.5 milligrams per 100 grams, averaging 10.0 milligrams per 100 grams with a S. D. of 1.99. The mangos of the Joe Welch variety contained more than twice as much ascorbic acid as the Haden variety. These values ranged from 21.4 to 28.9 milligrams per 100 grams, with a mean of 24.4 milligrams and S. D. of 2.69.

TABLE 10. Differences in the ascorbic acid content of mango varieties.*

VARIETY	ASCORBIC ACID
	mg./100 g.
Accession No. 1975	50
Bishop (2 seasons)	19–33
Boswell	30
Bombay yellow	5
Borsha	15
Brooks Late (2 seasons)	28–31
Cambodiana	35
"Cigar" (2 seasons)	119
Common (6 samples, 3 seasons, Manini)	70–142
Fairchild (6 samples, 3 seasons)	8–26
Goa Alphonse	43
Haden (8 samples, 3 seasons)	11–17
Hansen	5
Holt (4 samples, 3 seasons)	18–58
Joe Welch	22
Julie (2 seasons)	50–53
Kalihi	54
Kruse	20
Lemon Chutney	31
Moreland	35
Number 9	37
Ono	33
Paris	20
Pirie (6 samples, 3 seasons)	12–16
Pirie, Koboni	13
Pirie, Jordan	26
Pirie, seedling	28
Robinson	21
Sandersha	26
Seedlings	
1	34
2	37
3	92
4	97
Smith-Wootten	80
Strawberry	24
Whitney	13
Wilcox	11
Wootten (2 seasons)	51–90

* These data are mostly from TB 6; some are from TB 26 (35).

TABLE 11. Ascorbic acid variations in mangos of the Haden and Joe Welch varieties.

Joe Welch				Haden			
Sample	Wt. A.P.	Ascorbic Acid	pH	Sample	Wt. A.P.	Ascorbic Acid	pH
	g.	mg./100 g.			g.	mg./100 g	
1	328	28.9	4.2	1	326	8.7	
2	404	26.6	4.1	2	333	10.6	
3	437	21.4	4.2	3	350	10.0	
4	377	27.4	4.4	4	377	7.3	
5	430	23.5	4.4	5	372	8.7	
6	357	21.6	4.8	6	390	9.6	
7	390	22.6	4.2	7	322	9.4	
8	508	23.7	4.3	8	263	13.5	
9	463	26.2	4.2	9	293	9.1	
10	473	21.9	4.3	10	248	13.3	
Mean		24.4	4.3	Mean		10.0	3.9
S. D.		2.69		S. D.		1.99	
S. E.		0.85		S. E.		0.63	

The differences between the lowest and highest values for each variety are 6.2 and 7.5 milligrams respectively, which on the basis of our arbitrary scale previously described (p. 12), are true differences. These results indicate that even when mangos of the same variety and of similar maturity are grown under the same conditions, variations of some magnitude in the ascorbic acid content are to be expected.

There is little variation in the pH values of the individual Joe Welch mangos and it appears not to be related to the ascorbic acid content, as mangos with the same pH (4.2) had a range of 21.4 to 28.9 milligrams per 100 grams ascorbic acid. Nor did the size of the mangos appear to influence the ascorbic acid content of the fruit used for this study.

Stability of ascorbic acid in mango. To test the stability of ascorbic acid in half-ripe and ripe mango cheeks, fruits were peeled, halved, and opposite sides analyzed immediately after preparation and after standing 6 hours at room temperature (74° to 79° F.) under glass beakers.

The ascorbic acid values are compared with those previously published in TB 6 as follows:

Mango Sample and Degree of Ripeness	Time of Standing		Gain or loss
	None	6 Hours	
	mg./100 g.	*mg./100 g.*	%
Half-ripe (average, 2 lots of 3 fruit each)	104	110	+6
Half-ripe to green (3 fruit from TB 6)	61	59	−3
Ripe (5 fruit)	85	83	−2
Ripe (3 fruit from TB 6)	44	42	−4

It is obvious that there is little or no loss of ascorbic acid and that in mangos, which do not oxidize and darken on standing, this vitamin is very stable.

Ascorbic Acid Content of Papaya. In an earlier work (*27*) several special studies were reported on the ascorbic acid content of papaya with regard to stability, variation among fruit, ascorbic acid content of seeds, and effect of cooking. For this bulletin the work was repeated, and the findings which follow are in general agreement with those previously published.

Stability of ascorbic acid in papaya. Sections from three fruit, Solo variety, were used for immediate determination of the ascorbic acid content and similar sections were kept (unpeeled) for 2½ hours under a glass beaker in a well-lighted laboratory at room temperature (74° F.) before combining with acid in a Waring blendor. The ascorbic acid value for the sample analyzed immediately was 72.1 milligrams per 100 grams and the sample after 2½ hours, 70.6 milligrams per 100 grams, a loss of 2 percent. This small difference is within experimental error and demonstrates that, under the conditions described, the ascorbic acid content of papaya is very stable. This confirms the earlier work of this laboratory.

Variations in the ascorbic acid content of papaya. Since this department has already made two studies to determine the general influence of climate on the ascorbic acid content of papaya over periods of 11 months, further work was not done, but the results of the previous work are here summarized. In 1940–41, the range of ascorbic acid in 45 papayas harvested at weekly intervals from the Experimental Farm at Poamoho was 60 to 122, and 59 to 118 milligrams per 100 grams for 40 fruit from Kailua. When the values were plotted for the year, the highest values were found to occur in April, May, June, and October. For a more intensive study (*33*) over an 11-month period (1950), the ascorbic acid values were found to range from 87.3 to 105.4 milligrams per 100 grams of fresh ripe fruit, with the highest values occurring in the months of March, July, September, and October. The fruit for this study were obtained from the Station Farm in Manoa Valley, Honolulu.

For the earlier work, the mean ascorbic acid figures for papaya from the two areas were 81 and 88 milligrams per 100 grams, with 11 of the 85 papayas containing less than 70 milligrams per 100 grams. In the 1950 study, the mean value for 311 fruit was 97 milligrams per 100 grams, and for only 18 fruit did the values fall below 80 milligrams per 100 grams.

These studies prove that fresh ripe papayas are a reliable source of ascorbic acid when they are picked at the correct stage and properly handled. But, because the initial ascorbic acid values are high, it does not necessarily mean that the ascorbic acid content of products made from the fruit will also be high (see tables 5 and 6).

Ascorbic acid content of papaya seeds. Whole papaya seeds and the aril (the fleshy material surrounding the black seeds), from the fruit used for the stability study, were studied separately (see Methods). Their ascorbic acid contents were found to be 68.5 and 114.0 milligrams per 100 grams, respectively, whereas the flesh of the fruit contained 72 milligrams per 100 grams. These results are similar to those previously found but do not suggest the desirability of consuming papaya seeds. The seeds contain a highly irritating aromatic substance which makes them undesirable as human food. When fed to rats, the seeds caused serious intestinal disturbances and the animals finally refused to eat the food mixture containing them (unpublished data, this laboratory). One or two seeds may not be harmful when consumed with a half papaya, but people with sensitive digestive tracts would do well to avoid them.

Effect of cooking upon the ascorbic acid content of papaya. Halves from four fruit were baked in their skins for 20 minutes at 350° F. (*21*). The ascorbic acid content was determined on the fruit-acid (metaphosphoric) blends (see Methods) of sections of the fresh and cooked halves. When the cooked value was converted to the fresh weight equivalent, the ascorbic acid loss was zero.

A sauce was made by simmering papaya cubes from the same lot as above for approximately 10 minutes (until translucent) with a small amount of sugar and water (*21*). This procedure resulted in only 1 percent loss in ascorbic acid content after the cooked value was converted to the fresh weight basis.

These losses are smaller than previously reported (*27*), but both studies show that home cooking, by methods commonly recommended, causes little destruction of ascorbic acid in papaya.

Distribution of ascorbic acid in papaya. Analyses were made on bud, center, stem, and longitudinal sections of five papayas from one tree on the University campus in order to determine the variation of ascorbic acid within a fruit. These were large fruit of common variety weighing approximately 2 pounds each. The ascorbic acid values given below were obtained from single 20-gram samples titrated in duplicate.

Papaya	Bud section	Center section	Stem section	Longitudinal section
	mg./100 g.	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
1	89.3	86.6	80.5	82.7
2	79.4	76.6	75.3	76.6
3	83.4	88.7	67.2	83.4
4	83.9	87.5	80.6	87.8
5	107.4	93.7	75.5	95.6
Average	88.7	86.6	75.8	85.2

It would appear from this brief study that the bud and center sections are always higher in ascorbic acid than the stem end section of papaya, and that a longitudinal section seems to be most representative for the whole papaya.

Vegetables

Effect of Salt-Pickling and Bran-Salt-Pickling Upon Vitamin Content of Some Vegetables. The effect of salt-pickling and bran-salt-pickling upon carotene, three B vitamins, and ascorbic acid was determined for three vegetables—white mustard cabbage, daikon, and long eggplant. Since home practices differ in some details, one method was arbitrarily chosen for this experiment as representing the typical procedure used in Japanese homes in Hawaii (see pp. 65, 69, 70) (*19, 20*).

Table 12 summarizes the results of the study. The percentage increase or decrease in vitamin content was calculated on the dry weight basis because of the large changes in moisture content after pickling.

The changes in carotene content as a result of pickling white mustard cabbage tended to be smaller than for any of the other vitamins. Bran-salt-pickling destroyed little or no carotene, whereas salt-pickling reduced the carotene content 26 percent. The value for carotene in the fresh long eggplant was already low, and dropped to negligible amounts in the pickled products. Since there is no carotene in daikon, analyses were not made on these samples.

All three vegetables in the raw state contain only small quantities of thiamine and niacin and the destruction caused by salt-pickling reduced the original values to the extent of 20 percent or more. However, when rice bran was added with the salt, the thiamine and niacin values of the pickled vegetables exceeded those of the fresh vegetables with one exception. The thiamine content for all the vegetables increased 40 to 500 percent, confirming earlier work done at this Station using the rat-growth method (*19, 20*). The niacin value for bran-salt-pickled daikon and eggplant increased markedly (about 100 and 300 percent) but in the case of the white mustard cabbage there was practically no change. There appears to be no explanation for this. Since all bran clinging to the pickled vegetables was carefully washed off prior to assaying, it seems that thiamine and niacin were adsorbed, adsorption being greatest for daikon.

Rice bran is not a potent source of riboflavin and apparently it is not adsorbed by the pickled vegetables as are thiamine and niacin. It seems unlikely that riboflavin was destroyed during pickling, as the jars were kept out of light, but drying the white mustard cabbage in the sun prior to the pickling process (see p. 65) could have caused destruction in that vegetable.

The thiamine value obtained for rice bran used in this study (table 12) was similar to that reported by Kik (*16*) for rice bran from the Caloro variety of rice, but our figures for riboflavin and niacin exceeded his by about 70 percent (Kik's values: thiamine 2.410, riboflavin 0.266, and niacin 29.44 milligrams per 100 grams).

On the basis of an average-size serving (28 grams), bran-salt-pickled daikon would supply approximately 8 percent, and white mustard cabbage and eggplant only 2 to 3 percent of the recommended daily allowances for both thiamine and niacin. If eaten only once a day, the contribution to the day's need for these two vitamins would be small. But, if consumed three times a day with each meal, as is often customary in Oriental diets, then bran-salt-pickled daikon would contribute approximately 25 percent of the recommended daily allowances for both thiamine and niacin.

As would be expected, the ascorbic acid values dropped to minimal amounts after the vegetables had been pickled with either salt or salt and rice bran. The pickling procedure itself would tend to destroy this vitamin, and there would be none added by the rice bran.

Effect of Three Cooking Methods on the Thiamine, Riboflavin, and Niacin Content of Green Soybeans. The effect of three household cooking procedures upon the retention of three B vitamins in green soybeans was investigated using two varieties of soybeans. One lot of soybeans was boiled in the pods with enough boiling water to cover until done (method I); another was cooked as above for 5 minutes only (method IIA), then shelled and simmered until done (method IIB); and the third was cooked in a pressure saucepan (method III).

The results showed that when the simmering water in IIB was not discarded, this method was superior to the others in retaining thiamine and niacin but not riboflavin. When the water was discarded, IIB was generally the poorest method for all the vitamins. The pressure saucepan method was the best for riboflavin and second best for thiamine and niacin. Riboflavin appeared to be the best retained and niacin the most poorly retained vitamin.

Under the conditions of this experiment, the highest value for green soybeans with respect to vitamin content was obtained when the beans were parboiled 5 minutes to facilitate shelling, then shelled and cooked in a small amount of water until done, utilizing the cooking water. The cooked green soybeans used for the vitamin assays given in table 1 were prepared by this method (IIB). An alternative method that also resulted in good retention of the B vita-

TABLE 12. Vitamin content of three vegetables, fresh, salt-pickled, and bran-salt-pickled.

VEGETABLE	MOISTURE	CAROTENE			THIAMINE		
		As Assayed	Dry Weight	Increase or Decrease	As Assayed	Dry Weight	Increase or Decrease
	%	mg./100 g.	mg./100 g.	%	mg./100 g.	mg./100 g.	%
Cabbage, white mustard							
Raw	95.4	0.592	12.870		0.040	0.870	
Salt-pickled	89.8	0.971	9.520	−26	0.036	0.353	− 59
Bran-salt-pickled	89.2	1.380	12.778	− 1	0.135	1.250	+ 44
Daikon, long							
Raw	94.6	—	—	—	0.017	0.315	
Salt-pickled	87.7	—	—	—	0.023	0.187	− 41
Bran-salt-pickled	77.2	—	—	—	0.454	1.991	+532
Eggplant, long							
Raw	90.8	0.100	1.087		0.069	0.750	− 32
Salt-pickled	88.8	0.032	0.286	−74	0.057	0.509	
Bran-salt-pickled	88.3	0.010	0.085	−92	0.138	1.179	+ 57
Rice bran	8.3				2.265		

Table 12 (*Continued*). Vitamin content of three vegetables, fresh, salt-pickled, and bran-salt pickled.

Vegetable	Riboflavin			Niacin			Ascorbic Acid		
	As Assayed	Dry Weight	Increase or Decrease	As Assayed	Dry Weight	Increase or Decrease	As Assayed	Dry Weight	Increase or Decrease
	mg./100 g.	*mg./100 g.*	%	*mg./100 g.*	*mg./100 g.*	%	*mg./100 g.*	*mg./100 g.*	%
Cabbage, white mustard									
Raw	0.080	1.739		0.80	17.39		30.8	669.6	
Salt-pickled	0.094	0.922	−47	0.74	7.25	− 58	trace		−100
Bran-salt-pickled	0.115	1.065	−39	1.85	17.13	− 1	1.5	13.9	− 98
Daikon, long									
Raw	0.021	0.389		0.28	5.18		17.5	324.1	
Salt-pickled	0.032	0.260	−33	0.31	2.52	− 51	trace		−100
Bran-salt-pickled	0.034	0.149	−62	4.79	21.01	+306	trace		−100
Eggplant, long									
Raw	0.061	0.663		0.64	6.96		3.1	33.7	
Salt-pickled	0.075	0.670	+ 1	0.62	5.54	− 20	trace		−100
Bran-salt-pickled	0.069	0.590	−11	1.57	13.42	+ 93	trace		−100
Rice bran	0.471			49.50					

mins was the use of a pressure saucepan when care was exercised not to overcook the beans.

Details of the problem and the results have been published elsewhere (*6*).

Thiamine, Riboflavin, and Niacin in Dried Soybeans and Soybean Products. A study of the retention of thiamine, riboflavin, niacin, and other nutrients in Japanese soybean curd (*tofu*) made from dry soybeans has been published elsewhere (*24*). The figures for the mean values for the three B vitamins in three samples of each of the various products from three different tofu factories are summarized in table 13.

TABLE 13. Thiamine, riboflavin, and niacin in dried soybeans and soybean products.

(Averages of three samples of each.)

ITEM	MOISTURE	THIAMINE	RIBOFLAVIN	NIACIN
	%	*mg./100 g.*	*mg./100 g.*	*mg./100 g.*
Soybeans, dried	9.2	1.176	0.253	1.78
Soybean residue (*kirazu*)	80.7	0.100	.024	0.19
Soybean "milk" (*tonyu*)	93.0	0.095	.028	0.22
Water pressed from precipitated soybean "milk"		0.096	.037	0.22
Soybean curd (*tofu*)	84.1	0.073	.020	0.17
Water drained from soybean curd upon standing		0.059	0.011	0.12

Although dry soybeans appear to be a rich source of thiamine, riboflavin, and niacin, large amounts of these water-soluble vitamins are lost when the beans are made into soybean curd. Data on yields of tofu, and other products, from a known quantity of dry soybeans permit the conclusions which follow. Japanese-type soybean curd produced in Hawaii retains 10 to 25 percent of the thiamine, 15 to 25 percent of the riboflavin, and 20 to 40 percent of the niacin of the beans from which the curd is produced. Approximately half of the water-soluble vitamins are lost in the water pressed from the curd, and 5 to 12 percent stays in the soybean residue (*kirazu*).

Tofu contains about the same content of thiamine as cooked beef, but only about one-tenth as much riboflavin and one-twentieth as much niacin. Soybean curd has about the same thiamine and niacin content of cooked snap beans but is a poorer source of riboflavin. Soybean curd is most valuable as a source of readily digested protein and of calcium (*24*).

Thiamine, Riboflavin, and Niacin Contents of Taro and Poi. The results of a study of the retention of three B vitamins, thiamine, riboflavin, and niacin, when taro corms were cooked in the laboratory and when cooked by factory methods and made into *paiai* (commercial poi, 30 percent solids) have been published in detail elsewhere (*23*).

The average values for two varieties of taro (see table 1 for individual values) studied in the laboratory and the taro and paiai from three different poi factories are summarized in table 14. The varieties of the taro from the poi factories were unknown but represent typical products commonly processed.

TABLE 14. Taro as a source of thiamine, riboflavin, and niacin.

TARO	THIAMINE	RIBOFLAVIN	NIACIN
	mg./100 g.	*mg./100 g.*	*mg./100 g.*
Laboratory study:			
Taro corms, raw	0.194	0.028	0.64
Taro corms, cooked	.106	.028	.52
Factory study:			
Taro corms, raw	.222	.040	.76
Taro corms, cooked	.090	.028	.60
Taro corms, cooked and ground (*paiai*)	0.080	0.029	0.53

It may be noted that although the mean thiamine value for the raw corms from the poi factories was greater than that for the raw corms studied in the laboratory, the average value for the cooked was somewhat less, and when calculated on the dry basis, the retention of thiamine for the laboratory-cooked corms was about 70 percent and for the factory-cooked corms it was only 45 percent. More than 95 percent of the riboflavin and niacin was retained in the laboratory-cooked corms and about 85 percent for the factory-cooked corms. The long period of cooking employed in the factories is especially destructive to thiamine.

SUMMARY AND CONCLUSIONS

The number of foods assayed for vitamins was as follows: 214 for vitamin A (biologically active carotenoid pigments designated as carotene), 285 for thiamine, 283 for riboflavin, 285 for niacin, and 230 for ascorbic acid. These foods include some of tropical and semitropical origin and some characteristic of the diets of the racial groups living in the Islands, as well as common American foods produced or widely used in Hawaii. Three animal foods (milk, eggs, and opihi) were analyzed for vitamin A as well as carotenoid pigments and the other vitamins. All other foods were of plant origin.

The chemical and microbiological methods used are described. All pertinent data regarding quality and size of samples, as well as the source, treatment prior to analysis, percentage waste, and common and scientific names are given in the Appendix.

The major results are summarized in table form. For each vitamin studied, there are brief discussions regarding the values obtained for the raw foods, the effect of cooking, and the comparisons with standard tables.

A number of special studies, especially on ascorbic acid, are reported.

Confirming our previous results, and/or those of investigators elsewhere, the vegetables and fruits which proved to be the best sources of the vitamins were as follows: thin green leaves and deep-yellow fruits and vegetables for provitamin A; the various legumes and tender growing tips of some vegetables for thiamine, riboflavin, and niacin; and guava, some mangos, papaya, and leaves and growing tips of certain vegetables for ascorbic acid.

In general agreement with published reports, the carotene values of some foods appear to be enhanced when the foods are cooked, whereas the water-soluble vitamins are reduced in varying degrees, ascorbic acid being the most labile.

Some carbohydrate-rich foods, such as breadfruit, sweet corn, potato, sweetpotato, and taro, compare very favorably with grain products, even enriched ones, as sources of thiamine, riboflavin, and niacin on the isocaloric basis.

About half the vitamin A values are as good or better, and about half are less than typical values given in USDA publications. When our figures for carotene are compared directly with those for Central American foods, the agreement is better, only three Island foods showing lower values.

With few exceptions, the thiamine, riboflavin, and niacin contents of Hawaii foods are similar to average published values.

It is reaffirmed that a number of Hawaii-grown fruits, namely, papaya, guava, and some mangos, are superior to citrus fruits as sources of ascorbic acid. Some locally grown vegetables are also excellent sources of vitamin C, but for a considerable number of vegetables the ascorbic acid values are below those in USDA handbooks. Since most of these vegetables were obtained on the open market, it is suggested that conditions relating to harvesting and marketing, rather than variety and climate, were the factors probably responsible for the low values.

The ascorbic acid in mangos and papayas is very stable and little or no loss occurs on standing or during cooking, whereas in guavas the vitamin appears to be more labile.

Commercially processed Hawaii fruit juices and nectars available in retail stores in 1952 and 1954 were undependable sources of ascorbic acid. Guava products, once opened, rapidly lose ascorbic acid even under refrigerated storage.

Salt-pickling of vegetables destroys much of the vitamin content of white mustard cabbage, daikon, and eggplant, whereas bran-salt-pickling tends to enhance the thiamine and niacin contents, but has little or no effect upon the riboflavin. Both pickling methods completely destroy ascorbic acid. The carotene content of the white mustard cabbage is less affected by bran-salt-pickling than by salt-pickling.

The method of cooking can markedly influence the loss of the B vitamins from green soybeans.

When tofu, Japanese-type soybean curd, is made from dry soybeans, much of the original B vitamin content is lost.

Taro corms cooked by factory methods, for the making of commercial poi, lose more of the B vitamins, especially thiamine, than when home cooked.

APPENDIX

DESCRIPTION AND PREPARATION OF FOODS USED FOR VITAMIN ASSAYS

If no description is given, it should be understood that (1) the sample was of good market quality, (2) the variety was unknown if not listed, (3) those foods assayed in both the raw and cooked state were divided into two equal parts, (4) portions taken for assays constituted representative samples of the whole, and (5) unless otherwise stated, analyses were begun the same day as obtained. If the foods were received late in the afternoon, they were refrigerated overnight at 40° F. in vegetable hydrators or plastic bags and analyses were started the following day. See page 9 for Experimental Procedure, including sampling and cooking.

For the scientific names, a number of University publications (*10, 22, 26, 28, 42*), and U. S. Department of Agriculture handbooks 8 and 34 (*40, 17*) were used. Many of the names were checked with the departments of Vegetable Crops and Horticulture.

The word variety refers to horticultural not botanical variety. TB 6 as referred to in this section is HAES Technical Bulletin No. 6, *Vitamin Values of Foods in Hawaii*, published in 1947. A.P. means "as purchased" and E.P., "edible portion." Unless otherwise specified, the weights of the samples in pounds were all A.P. and dimensions are given as length followed by width or diameter.

The total number of samples for which vitamins were determined were counted as follows:

(a) Each horticultural variety was counted separately (Hawaiian wonder, Kentucky wonder, and Lualualei beans constituted separate samples).

(b) Variations in the foods, such as degree of ripeness (green and ripe breadfruit) and size (large and small Chinese preserving melon), made up separate samples.

(c) With processed foods such as in the salt-pickling study, each product was considered a separate sample.

(d) If different sections of a food were analyzed and reported, these constituted separate samples (cucumber, peeled and unpeeled); or if different parts of the same species such as leaves and roots or leaves and fruit were determined, these were tabulated as separate samples (taro, leaves and corms; cowpeas, leafy tender tips, green pods, and seeds).

(e) The raw and cooked portions of a food formed separate samples.

Asparagus (*Asparagus officinalis*): Analyzed raw and cooked. Sample, 3¼ pounds, Oahu grown, obtained from the wholesaler the same day it was delivered by the grower. Size range, 9 x 3/8 to 5/8 inches; fresh quality, good green-colored asparagus. Tough ends were broken off, and only the tender tips used. Coarsely cut and mixed before subsampling. Cooked by steaming for 20 minutes. (See p. 9.) All vitamins determined. Waste (tough ends), 30 percent.

Avocado (*Persea americana*) : Analyzed raw only.

A. Guatemalan (skin thick and woody in texture)

Kanola: Sample, three fruit totaling 2¼ pounds from the Station Farm, Kona, Hawaii. Kept at room temperature in the dark until ripe. Average size, 3¼ x 3¾ inches; round-shaped fruit with thick, black skin. Total sample peeled and blended before subsampling for all vitamins. Waste (skins and seeds), 36 percent.

Kashlan: Sample, three fruit totaling 2 pounds from the Station Farm, Kona, Hawaii. Kept at room temperature in the dark until ripe. Average size, 3½ x 4¼ inches; fruit round with rough, green skin; seed small and round; flesh free from fibers but watery. Total sample peeled and blended before subsampling for B vitamins and carotene. Waste (skins and seeds), 25 percent. Later, three fruit of same source and description as above used for ascorbic acid analysis.

Manik: Sample, three fruit totaling 2 pounds obtained from the Station Farm, Poamoho, Oahu. Sample peeled and blended before subsampling for B vitamins only. Waste (skins and seeds), 42 percent.

B. Guatemalan–Mexican Hybrid

Fuerte: Sample, three fruit totaling 1¾ pounds from the Station Farm, Kona, Hawaii. Fruit kept at room temperature in the dark until ripe. Size range, 3¾ x 3⅛ to 4⅜ x 3⅛ inches; pear-shaped with medium-large seed and thin, green skin. No fibers in the flesh. Total sample peeled and blended before subsampling for B vitamins and carotene. Waste (skins and seeds), 36 percent. Later, four fruit of same source and description as above used for ascorbic acid analysis only.

C. Guatemalan–West Indian Hybrids

Beardslee: Sample, two fruit totaling 3 pounds from Manoa Valley. Size range, 5 to 5½ inches long; large fruit, flesh yellow-colored and at optimum maturity. Half of each blended before subsampling for thiamine, riboflavin, and niacin. Waste (skins only), 19 percent. Later, three fruit from the same source used for niacin and carotene determinations. The niacin value is an average of data on these two samples. A composite of six fruit from the same source formed the ascorbic acid sample.

Lehua: Sample, two fruit totaling 2¾ pounds from the Station Farm, Kona, Hawaii. Kept at room temperature in the dark until ripe. Average size, 6½ x 5½ inches; fruit large and somewhat pear-shaped with dark, medium-thick skin. Quarters removed for subsampling for ascorbic acid analysis only. Waste (skins and seeds), 36 percent.

D. West Indian Race

Hulumanu: Sample, three fruit totaling 3¾ pounds from the Station Farm, Kona, Hawaii. Kept at room temperature 4 days to ripen, and refrigerated 2 days. Size range, 6½ to 8 inches long; flesh slightly bitter and stringy. Generally of poor quality. The total sample peeled and blended before subsampling for B vitamins only. Waste (skins and seeds), 22 percent.

Seyde: Sample, three fruit totaling 3¼ pounds from the Station Farm, Kona, Hawaii. Kept at room temperature 4 days to ripen, and refrigerated 2 days. Size range, 5¼ to 5½ inches long; purple skin and dark strings in the flesh, but otherwise smooth with good and sweet flavor. Sample, of generally poor quality. B vitamins determined. Later, two fruit from the Station Farm, Poamoho, Oahu, of same general description allowed to ripen in the dark 6 days and used for carotene analysis only.

West Indian type: Sample, four fruit totaling 2¾ pounds from the Station Farm, Kona, Hawaii. Average size, 5½ x 2¾ inches; skin green with some brown areas; flesh firm-ripe when used. Total sample peeled and blended before subsampling for carotene and ascorbic acid analyses only.

Banana Bud (*Musa paradisiaca*): Analyzed raw only. Sample, four buds (Chinese banana) totaling 5½ pounds from the Station Farm, Manoa Valley. Size range, 5 x 3 to 6½ x 4 inches. Sample for analyses included inner light-colored bracts and flower heads adhering to both inner and outer bracts. Bracts were chopped but adhering flowers were left intact. B vitamins and carotene determined. Waste (outer bracts and petals), 73 percent. Ascorbic acid value taken from TB 6.

Banana (Cooking)–See Plantains

Banana (Eating) (*Musa paradisiaca* var. *sapientum*): Analyzed raw only.

Bluefields: Sample, three fruit totaling 1¼ pounds grown at Waimanalo, purchased on the market. Average size, 7 inches long. Skin completely yellow with some brown flecks, but no bruises. Fruit peeled and blended before subsampling for B vitamins. Waste (skins), 31 percent. Later, carotene determined on blend of four fruit of same general description as above. Waste (skins), 30 percent. Ascorbic acid value from TB 6.

Brazilian: Sample, 10 fruit totaling 3 pounds from one hand, grown in Honolulu. Size range, 6 x 1¾ to 7 x 2 inches; firm-ripe and of good quality. Peeled and blended before subsampling. All vitamins determined. Waste (skins), 34 percent.

Chinese: Sample, five fruit totaling 1¾ pounds from the Station Farm, Manoa Valley. Average size, 6½ x 1½ inches. Skins of two fruit completely yellow color and three light-yellow with green tinge at stem. All mottled with brown. Peeled and blended before subsampling for B vitamins. Waste (skins), 31 percent. Later, seven bananas from same source allowed to ripen at room temperature; peeled and blended for carotene analysis. Waste (skins), 38 percent. Ascorbic acid value from TB 6.

Cuban Red: Sample, seven fruit totaling 1¾ pounds from the Station

Farm, Poamoho, Oahu. Size range, 4¼ x 1¾ to 4⅝ x 1⅞ inches; reddish-colored skin. Peeled and blended before subsampling for all vitamins. Waste (skins), 24 percent.

Ice Cream: Sample, eight fruit totaling 2¼ pounds taken from three hands of one bunch from the Station Farm, Poamoho, Oahu. Size range, 5 x 2½ to 6 x 1⅞ inches; fully ripe, but not soft. Peeled and blended before subsampling for all vitamins. Waste (skins), 33 percent.

Lacatan: Sample, 10 fruit totaling 3 pounds taken from 10 hands of one bunch from the Station Farm, Poamoho, Oahu. Size range, 6 x 1½ to 7¼ x 1⅝ inches. Skin greenish-yellow when ripe. Fruit at firm-ripe stage blended before subsampling for all vitamins. Waste (skins), 31 percent.

Bean Sprouts, Mung (*Phaseolus aureus*): Analyzed raw and cooked. Sample, 1-pound package purchased on the market, of good fresh quality. Cooked by steaming for 5 minutes, then blended. B vitamins determined. Later, carotene determined on a ¾-pound sample of same source, description, and preparation as above, except cooked sample steamed 10 minutes. No waste. Ascorbic acid values from TB 6.

Bean Sprouts, Soy (*Glycine max*): Analyzed raw and cooked. Source and preparation of 1-pound package were the same as for mung bean sprouts. Later, carotene and ascorbic acid determined on separate 1-pound samples of same source and preparation as above; sample for ascorbic acid steamed 5 minutes, sample for carotene steamed 20 minutes.

Beans, Green (*Phaseolus vulgaris*): Analyzed raw and cooked. All green beans were obtained from the same source and same area—the Station Farm, Manoa Valley, but at different seasons. The beans were cooked by steaming for 15 minutes.

Hawaiian Wonder: Sample, 1½ pounds. Size range, 3 x ¼ to 7 x ½ inches; in various stages of maturity. B vitamins determined. Waste (strings and ends), 7 percent. Later, a 1½-pound sample was used for carotene and a 3¼-pound sample for ascorbic acid analyses. Waste (ends), 5 percent.

Kentucky Wonder: Sample, 3¼ pounds. Size range, 7½ x ¼ to 8 x ½ inches; young, tender, dark-green beans. All vitamins determined. Waste (ends), 4 percent.

Lualualei: Sample, 3 pounds. Size range, 6¼ x ½ to 8½ x ⅝ inches; beans flat and light green. All vitamins determined. Waste (ends), 2 percent.

Beans, Green Lima (*Phaseolus lunatus* var. *macrocarpus*): Analyzed raw and cooked. Sample, 9 pounds picked from plants on the Station Farm, Manoa Valley. Beans ranged from ½ x ¼ to 1 x ¾ inches; somewhat mature. Shelled beans were cooked by steaming for 25 minutes. All vitamins determined. Waste (pods), 73 percent.

Beans, Hyacinth (*Dolichos lablab*): Analyzed raw and cooked. Sample, 2½ pounds, purchased on the market. Size range, 3¼ x ¾ to 4¼ x 1⅛ inches; good, fresh, tender quality. Cooked by steaming for 10 minutes. All vitamins determined. Waste (ends and strings), 5 percent.

Beans, Yellow Wax (*Phaseolus vulgaris*): Analyzed raw and cooked. Sample, 3 pounds purchased on the market. Size range, 4 x 1/4 to 8 x 1/2 inches; young, tender, and of good quality. Beans were cut in half and cooked by steaming for 20 minutes. B vitamins and carotene determined. Waste (ends), 6 percent. Ascorbic acid determined on a 1-pound sample of top quality picked from plants on the Station Farm, Manoa Valley, morning of analysis, ranging in size from 3 1/2 to 5 3/4 inches. Beans were cut into thirds and cooked by steaming for 20 minutes. Waste (ends), 4 percent.

Beet Greens (*Beta vulgaris*): Analyzed raw and cooked. Sample, 4 pounds purchased on the market. Plant length, 7 1/2 to 11 inches; leaf width, 3/4 to 3 inches. Of good quality except for some bruises and insect damage. Young beets not included in the sample. Raw sample chopped finely and blended before subsampling. Remaining half cut into 1- to 1 1/2-inch lengths, and cooked by steaming 10 minutes. Riboflavin, niacin, and carotene determined. Waste (including damaged areas), 12 percent. Later, thiamine determined on a 2/3-pound sample of same source, description, and preparation as above. Ascorbic acid determined on a 1-pound sample purchased at the market of same general description and preparation as above.

Beets (*Beta vulgaris*): Analyzed raw and cooked. Sample, 10 beets, 1 1/3 pounds from the Station Farm, Manoa Valley. Five beets used raw; five left whole, unpeeled, and cooked by immersing in boiling water for 40 minutes. Chopped before subsampling for B vitamins. Waste (tap roots, skins, and tops), 37 percent raw; 36 percent cooked. Later, a 1 1/2-pound sample from the Station Farm at Poamoho, Oahu, used for carotene analysis. Preparation same as above. For ascorbic acid, 13 fresh, young beets were purchased on the market. Average size, 1 1/2 x 2 1/4 inches. Six beets used raw; seven cooked as stated above for 20 minutes. Waste (tap roots, skins, and 1-inch tops), 21 percent raw; 22 percent cooked.

Belembe (Tahitian Taro) (*Xanthosoma brasiliense*): Analyzed raw and cooked. Sample, 2 pounds from home garden, Manoa Valley. Size range, 2 1/2 x 7 to 12 x 13 inches; of top quality. Only the tender stems 4 to 6 inches in length and leaves used. The raw sample was cut into 1/4- to 1/2-inch pieces and thoroughly mixed; the other half was cut into 2-inch lengths, cooked in a small amount of water for 10 minutes, and blended with residual cooking water before subsampling. Waste (tough stems), 3 percent. Values for riboflavin, raw and cooked, and niacin for the cooked product, were obtained on another 1 1/3-pound lot obtained from the same source. Description and preparation same. Waste (tough stems), 12 percent. Ascorbic acid values from TB 6.

Bitter Melon Fruit (*Momordica charantia*): Analyzed raw and cooked. Two samples, 3 1/4 and 4 pounds of Oahu-grown fruit purchased on the market at different times for analyses. Fresh, young, and tender. Cut crosswise into 1/2-inch slices, unpared, and mixed. Cooked by steaming 15 minutes. Both raw and cooked samples chopped and blended before subsampling. Waste (seeds and inner membranes), 18 percent. Niacin figures are averages of data on both samples. Thiamine, riboflavin, and carotene values are from the first sample only. Ascorbic acid values from TB 6.

Bitter Melon Leafy Tender Tips (*Momordica charantia*) : Analyzed raw and cooked. Sample, two bunches, 3 pounds, Kaneohe grown, purchased on the market. Leaves varied in length from bud to 3½ inches; of fresh quality; only tender tips and leaves used for analyses. Cooked by steaming for 10 minutes. Both raw and cooked samples blended before subsampling. Waste (tough stems and spoiled leaves), 42 percent. Later, thiamine determined on a 1-pound sample of same general description and prepared in the same manner as above. Waste (tough stems and bruised leaves), 48 percent. Ascorbic acid values from TB 6.

Breadfruit, Green (*Artocarpus incisus*): Analyzed raw and cooked. Sample, four fruit totaling 6⅓ pounds picked at mature green (*tepau*) stage from trees on the University campus. Size range, 4 x 4 to 5½ x 4¼ inches. Two fruit used for raw sample; two fruit cooked by baking at 350° F. for 1 hour. Both raw and cooked samples peeled and chopped before subsampling for riboflavin, niacin, and carotene determinations. Waste (skins, cores, and stems), 40 percent raw and 22 percent cooked. Later, three fruit from the same source used for ascorbic acid analysis. Each fruit split and half of each used for raw and cooked samples; the halves were individually wrapped in aluminum foil and cooked as above. Waste, 22 percent raw and 8 percent cooked. At another season, four fruit from same source used for thiamine assay. Size range 7½ x 5½ to 8⅝ x 5¾. Preparation same as for ascorbic acid assay but, because the fruit were larger, cooked 1½ hours. Waste, 28 percent raw and 22 percent cooked.

Breadfruit, Ripe (*Artocarpus incisus*) : Analyzed raw and cooked. Sample, three fruit from one tree on the University campus. Picked green, allowed to ripen at room temperature, and refrigerated until analyzed. One fruit used for raw sample; two cooked by baking for 1 hour at 350° F. for thiamine and riboflavin determinations. Later, two fruit obtained from tree on University campus used for carotene analysis. One fruit chopped for raw sample; one fruit cooked by baking for 1 hour at 350° F., peeled, and blended. Three fruit totaling 5⅓ pounds obtained from the same source for ascorbic acid and niacin analyses. When picked, skin yellow-green to brown. Allowed to ripen completely. Size range, 5 x 4¾ to 5½ x 4½ inches. Split lengthwise for raw and cooked samples. Three halves individually wrapped in aluminum foil and cooked by baking as described above. Waste (skins, stems, and cores), 24 percent raw and 21 percent cooked.

Broccoli (*Brassica oleracea* var. *italica*) : Analyzed raw and cooked. Sample, one main head and six secondary heads, ½ pound of mixture of varieties, mostly Cicco grown at the Station Farm, Manoa Valley. Head span, ¾ x ⅞ to 3¾ x 4½ inches. Small leaves around the heads also used. Cooked by steaming for 15 minutes; both raw and cooked samples chopped before subsampling for B vitamins. No waste. Carotene determined on a separate sample. Later, 12 stalks totaling 2 pounds, Oahu grown, purchased on the market for ascorbic acid analysis. Size range, length, 10 inches; buds 2 to 3 inches in diameter; stems ½ to 1 inch in diameter; with good green color, and heads still in the bud stage. Only tender part of stems used. Six stalks each for raw and cooked samples; stems split down middle and cooked with heads by steaming 15 minutes. Waste (tough stalks and leaves), 45 percent.

Burdock Root (Gobo) (*Arctium lappa*): Analyzed raw and cooked. Sample, 12 roots, 2½ pounds, grown Waimea, Hawaii, purchased on the market. Size range, 15¼ to 29¾ x ⅝ to ⅞ inches; of top quality. Six roots each for raw and cooked samples; brown skin scraped off; cooked by steaming for 30 minutes. Both samples chopped before subsampling for thiamine and riboflavin determinations. Waste (scrapings), 24 percent. Later, 10 roots of same general description as above purchased on the market for niacin and ascorbic acid analyses. Five roots used for raw sample; and five cut into ½-inch lengths and steamed 30 minutes. Waste (scrapings), 23 percent.

Cabbage: Analyzed raw and cooked.

Chinese or celery cabbage (*Brassica pekinensis*): Sample, two large heads totaling 4 pounds purchased on the market. Each head divided into equal portions for raw and cooked samples. Cut into 1-inch pieces and cooked by steaming for 10 minutes. Both samples chopped before subsampling for B vitamins. Later, carotene determined on two heads grown on the island of Hawaii, purchased on the market. Size range, 9 to 10 x 3½ inches; of good quality. Quartered and opposite quarters used for raw and cooked samples. Cut into 1½-inch lengths and steamed 10 minutes. Waste (bases), 3 percent. Three heads totaling 2 pounds picked from plants on the Station Farm, Manoa Valley, morning of analysis for ascorbic acid. Size range of leaves, 3½ x 2¼ to 14½ x 8 inches; young and tender with white stalks and light-green leaves. Each leaf split lengthwise for raw and cooked samples. Raw sample coarsely cut and mixed. Other half cut into 1-inch pieces, steamed 10 minutes. Waste (bases), 2 percent.

Green mustard (*Brassica juncea*): Sample, six heads totaling 2¾ pounds purchased on the market same day as received from the Oahu grower. Largest leaves, 12½ inches long. Three heads each for raw and cooked samples. Cooked by steaming for 10 minutes. Both samples blended before subsampling for B vitamins. Waste (wilted leaves and bases), 6 percent. Later, three heads totaling 2⅓ pounds purchased on the market for carotene and ascorbic acid analyses. Average size, 14 inches long; good quality. Heads divided into two equal sections for raw and cooked samples. Cut into 1-inch sections and steamed 10 minutes. Waste (bases), 1 percent.

Head (*Brassica oleracea* var. *capitata*): Copenhagen variety. Sample 1, three heads totaling 10 pounds from the Station Farm, Poamoho, Oahu. Cabbages cut in halves and wedges from each used for the raw and cooked samples. Cooked by steaming for 10 minutes. Samples chopped before subsampling. Waste (cores and outside bruised leaves), 15 percent. Analysis repeated on two heads totaling 5¾ pounds, Maui grown, obtained from the wholesaler (Sample 2). Size range, 7 x 6½ to 7 x 8 inches; of good fresh quality. Total sample sliced and divided equally for raw and cooked samples. Cooked by steaming for 10 minutes. Both samples blended before subsampling. Waste (cores), 11 percent. Ascorbic acid and carotene determined on two heads (Sample 3) totaling 2 pounds of Oahu-grown cabbage obtained from a wholesaler. Average size, 4 x 4½ inches; fresh quality, one head darker green. Half of each head used for raw and cooked samples. Cut into four sections lengthwise and cooked by steaming for 10 minutes. Waste (cores), 7 percent. Thiamine values are from the first sample only, niacin values are averages of data from the first two samples, riboflavin from the second sample only, and carotene and ascorbic acid from the third sample.

White mustard (*Brassica chinensis*):

Sample 1. Multiple plants, 2¾ pounds, Oahu grown, purchased on the market. Divided for raw and cooked samples. Cut into 2-inch pieces and steamed 10 minutes. Both samples chopped finely before subsampling for thiamine and niacin. Later, riboflavin determined on three plants of same general description as above. Total amount cut into 1-inch pieces, mixed, and divided. Cooked as above. Waste (bases), 6 percent. For carotene analysis seven plants totaling 2 pounds purchased on the market. Raw sample chopped and blended. Other half cut into 1-inch pieces, steamed 10 minutes, and blended. Waste (bases), 2 percent. Four plants grown on the Station Farm, Manoa Valley, picked morning of day analyzed for ascorbic acid. Size range, leaves, 4¼ x 2¼ to 15¾ x 8 inches. Each leaf split lengthwise for raw and cooked samples and prepared as for riboflavin analysis. Waste (bases), 7 percent.

Sample 2. Analyzed (a) raw, (b) salt-pickled, and (c) bran-salt-pickled cabbage. Sample, 20 heads white mustard cabbage totaling 10 pounds, Oahu grown, purchased on the market. Size range, 9 x 2 to 16 x 4 inches; of good quality. Two pounds used for raw sample, and 4 pounds each for salt and rice bran-salt pickling. All vitamins determined. Total raw sample cut into 1-inch pieces and mixed before subsampling. Cabbage for pickling wilted out-of-doors in the sun 2 hours.

To make the salt-pickled product, the wilted cabbage was put in pickling crock, a salt solution (ratio of 1½ tablespoons common crystalline salt dissolved in ¾ cup cold distilled water per each pound vegetable) was poured over the cabbage, and the whole gently mixed. Weighted down with a loosely fitting wooden cover and bricks covered with aluminum foil. Cabbage stirred daily and kept at room temperature for 3 days. Washed to remove excess salt, cut, and mixed as for raw sample.

To make the bran-salt-pickled product, the wilted cabbage was placed in a pickling jar with alternate layers of a salt-rice bran paste (2 tablespoons salt, 2 cups rice bran, and 1 cup water per pound of cabbage made into a paste) and kept as above for 3 days. Washed carefully to remove all traces of rice bran before cutting for subsampling. Weight loss; salt-pickled, 45 percent; bran-salt-pickled, 44 percent. Waste (bases and damaged leaves), 5 percent.

Sample 3. Commercial salt-pickled cabbage, 1⅔ pounds E.P., purchased on the market. Coarsely cut and mixed before subsampling for B vitamins and carotene. No waste.

Cactus Fruit (*Opuntia magacantha*): Analyzed raw only. Sample, 28 fruit totaling 5½ pounds picked on the Waianae side of Oahu the day prior to analysis. Refrigerated overnight. Average size, 3¼ x 2 inches; dark-red color. Thorns scraped off and total blended before subsampling for B vitamins and ascorbic acid. Waste (thorns, stems, and bud ends), 3 percent. Later, carotene determined on a sample of eight fruit of same general source, description, and preparation as above.

Carambola (*Averrhoa carambola*): Analyzed raw only. Sample, 18 fruit totaling 3¼ pounds picked day prior to analysis from tree in Honolulu. Size range, 2⅜ x 1¾ to 3½ x 2½ inches; large translucent firm-ripe fruit, yellowish color with tinge of green. Cut and blended before subsampling for B vitamins and carotene. Waste (seeds and damaged areas), 5 percent. Ascorbic acid value from TB 6.

Carissa (*Carissa grandiflora*): Analyzed raw only. Sample, 64 fruit totaling 2 pounds picked Wilhelmina Rise same day analyzed. Size range, 1¼ x ⅝ to 2 x 1½ inches; fairly good quality, some with fruit fly stings. Cut and mixed before subsampling for all vitamins.

Carrots (*Daucus carota*): Analyzed raw and cooked. Sample, 20 roots, 4½ pounds, Maui grown, obtained from a wholesaler. Size range, 4 x 1¼ to 6½ x 1½ inches; fresh quality. Ten roots each for raw and cooked samples. Cut into ¼-inch slices and steamed 20 minutes. Both samples blended before subsampling for B vitamins and carotene. Waste (slice from tops and scrapings), 3 percent. Later, nine carrots totaling 2 pounds from the Station Farm, Manoa Valley, harvested day previously and refrigerated, used for ascorbic acid analysis. Size range, 4½ x 1¼ to 6¼ x 2 inches. Split lengthwise for raw and cooked samples. Sample for cooking prepared as above. Waste (1-inch stems, slices from tops, and scrapings), 7 percent.

Cauliflower (*Brassica oleracea* var. *botrytis*): Analyzed raw and cooked. Sample, 2¾ pounds, Snowball variety, from the Station Farm, Poamoho, Oahu. Broken into flowerets, mixed, and divided for raw and cooked samples. Cooked by steaming for 15 minutes. Both samples chopped finely before subsampling for B vitamins. Carotene determined on two heads totaling 1¾ pounds from same source. Prepared as above. Three heads purchased on the market for ascorbic acid analysis. Average size, 4 x 6 inches; excellent quality. Prepared as above. Waste (outer leaves), 23 percent.

Celery (*Apium graveolens*): Analyzed raw and cooked.

Sample 1. One bunch, 2¾ pounds, grown on island of Hawaii obtained from a wholesaler 2 years later. Size range, 15 x 4¾ inches at the base, 1-inch pieces, steamed 10 minutes, and blended. B vitamins determined. Waste (leaves, strings, and bruised parts), 25 percent.

Sample 2. Two bunches, 5½ pounds, grown in Waialua, Oahu, obtained from a wholesaler 2 years later. Size range, 15 x 4¾ inches at the base, stalks 7¾ x ⅝ to 15 x 1⅛ inches. Cut into 1-inch pieces and divided for raw and cooked samples. Cooked by steaming 20 minutes and blended. All vitamins determined. Waste (leaves, cores, tough stalk ends), 34 percent.

Chard (*Beta vulgaris* var. *cicla*): Analyzed raw and cooked. Sample, 1¾ pounds (7 leaves) obtained from a wholesaler. Size, total length 24 inches and leaf size 14 x 11 inches. Leaves were cut crosswise into ¼-inch and stems into $\frac{1}{16}$- to ⅛-inch slices. Total mixed and divided for raw and cooked samples. Cooked by steaming for 10 minutes. Riboflavin and niacin determined. Waste (stem ends), 2 percent. Later, 15 leaves totaling 1¼ pounds purchased on the market for thiamine and carotene analyses. Size range, total length 13 to 19½ inches; leaf width, 4¾ to 8 inches; of good quality. Leaves cut into 1-inch and stems ½-inch pieces. Divided and prepared as above. Ascorbic acid values from TB 6.

Chayote (*Sechium edule*): Analyzed raw and cooked. Sample, five fruit totaling 3 pounds purchased at the market. Size range, 3¼ x 2½ x 4½ to 4 x 3 x 2 inches; many fruit fly stings (which did not penetrate beneath the skin). Cut into halves for raw and cooked samples; sliced in $\frac{1}{16}$- to ⅛-inch pieces unpeeled. Cooked by steaming for 30 minutes. Riboflavin, niacin, carotene, and ascorbic acid determined. Waste (inner cores and surface fruit fly stings), 5 percent. Later, four fruit totaling 3½ pounds purchased on the market for thiamine analysis. Stored overnight in refrigerator. Size range, 4⅝ x 3 to 5⅛ x 3¾ inches; of very good quality. Prepared as above. Waste (inner cores) 2 percent.

Coconut (*Cocos nucifera*): Analyzed raw only.

Immature nuts: Sample, 16 nuts obtained from trees on University campus. When picked, all husks were green with some showing yellowish hue and dry on ends. Husked same day as picked and stored 3 days at 3° C. Separated into three groups by thickness and firmness of the meat; (1) very soft, meat from $\frac{3}{16}$ to $\frac{5}{16}$ inch thick, 240 to 500 milliliters liquid; (2) soft, meat ¼ to $\frac{5}{16}$ inch thick, 230 to 420 milliliters liquid; (3) medium, meat $\frac{7}{16}$ to ½ inch thick, 205 to 235 milliliters liquid. Meat chopped before subsampling for B-vitamin assays. The water from the coconuts with very soft and soft meat was combined for the B-vitamin assays. Water filtered before subsampling.

Mature nuts: White meat and water. Sample, six mature nuts with brown husks later obtained from same source. Meat ranged from ½ to $\frac{9}{16}$ inch thick, 80 to 365 milliliters liquid. Without removing the meat from the shells, it was grated in the Polynesian manner by using a serated iron grater attached to a board. Grated coconut well mixed before subsampling for thiamine and riboflavin assays. Waste (shells and small amount of meat adhering to the shells), 39 percent. Later, six mature nuts obtained from same source as above, and prepared in the manner previously described, for niacin assays of mature meat and water. Waste (shells and small amount of meat adhering to shells), 39 percent. Ascorbic acid determined on composite sample of water from the 21 mature nuts used for coconut cream.

The ascorbic acid values for mature and immature coconut meat taken from TB 6.

Coconut cream: Sample, 21 mature coconuts gathered from trees in Manoa Valley over a 4-week period. The water was first removed by piercing the eyes of the coconuts and draining it out. A composite of the water from all the nuts was made. The meat was grated in the Polynesian manner as above. The entire sample of grated coconut meat was equally divided for the preparation of two types of coconut cream (i.e. with and without added water).

Sample 1 was prepared by expressing the cream with a household screw-type press without the addition of water. Small quantities (approximately 2 cups) of grated coconut were placed in one thickness of cheesecloth and as much cream as possible expressed.

Sample 2 was prepared by adding 4¾ cups coconut water from the composite sample to approximately 3750 grams grated coconut, kneading the mixture, and expressing the cream as above.

The B vitamins and ascorbic acid determined on the two types of cream, and ascorbic acid determined on the coconut water.

Corn (*Zea mays*): Analyzed raw and cooked. Sample, 20 ears, 9¼ pounds, Hawaiian sugar variety, from the Station Farm, Poamoho, Oahu. Size range, 6 to 8½ inches long unhusked. Twelve ears used for raw sample; eight cooked in boiling water for 5 minutes, cut from the cobs, and blended. B vitamins determined. Waste (husks), 30 percent; (cobs), 33 percent raw and 41 percent cooked. Later, seven ears, 4 pounds, Maui grown, obtained from a wholesaler for carotene analysis. Size range, 7½ to 8½ x 1¾ inches. The corn from three ears was cut off the cob and blended for the raw sample. Four ears cooked as above. Waste (husks, silks, and cobs), 63 percent raw. Ascorbic acid determined on 14 ears totaling 5½ pounds from the Station Farm, Manoa Valley. Size range, 5 x 1¾ to 7 x 2 inches. Seven ears each for raw and cooked samples. Cooked as above. Waste (cobs), 52 percent both raw and cooked.

Cowpeas (*Vigna sinensis*): Analyzed raw and cooked.

Green pods with immature seeds: Sample, 2¼ pounds purchased on the market. Size range, 7 x ⅜ to 12 x ⅝ inches; of good fresh quality. Cut into 1½- to 2-inch lengths and divided for raw and cooked samples. Cooked by steaming for 15 minutes. B vitamins and carotene determined. Waste (ends and strings), 7 percent. Ascorbic acid values from TB 6.

Fresh seeds: Sample totaling $4\frac{1}{4}$ pounds from the Station Farm, Manoa Valley. Size range, pods $6\frac{1}{2}$ to $8\frac{1}{2}$ x $\frac{3}{8}$ inches; beans at "lima bean" stage; good fresh quality. Shelled and divided for raw and cooked samples. Cooked by steaming for 20 minutes. All vitamins determined. Waste (pods), 41 percent.

Tender tips: Sample, 3 pounds, Oahu grown, purchased on the market. Four to 5 inches tender tips and leaves of good quality used. Cut into 1- to 2-inch pieces and divided for raw and cooked samples. Cooked by steaming for 10 minutes. B vitamins and carotene determined. Waste (less tender, bruised, and damaged sections), 56 percent. Ascorbic acid values from TB 6.

Cucumber (*Cucumis sativus*): Analyzed raw only. Sample, 17 cucumbers, $6\frac{1}{4}$ pounds from the Station Farm, Manoa Valley. Size range, 6 x 2 to $7\frac{1}{2}$ x $2\frac{1}{4}$ inches; of good quality. Each cucumber split lengthwise and divided for pared and unpared samples. All vitamins determined. Waste (thin parings and ends), 9 percent.

Daikon (*Raphanus sativus* var. *longipinnatus*):

Sample 1. Analyzed raw only. Sample, six roots of long type totaling $3\frac{3}{4}$ pounds grown on island of Hawaii obtained from a wholesaler. Size, $8\frac{1}{2}$ to 14 x $1\frac{1}{2}$ inches. Pared, cut, and blended for B vitamins. Waste (parings), 11 percent.

Sample 2. Analyzed (a) raw, (b) salt-pickled, and (c) bran-salt-pickled. Sample, 11 roots, of long type, 10 pounds purchased on the market. Size range, 12 x $1\frac{5}{8}$ to 15 x 2 inches; cut into thirds and mixed. Two pounds used for raw sample, and 4 pounds each for salt- and for bran-salt-pickling. B vitamins and ascorbic acid determined.

To make the salt-pickled product, the daikon was placed in pickling crock and salt equal to 5 percent of its weight sprinkled over layers of daikon. Weighted down with a round board placed over the top. Daikon mixed once daily and removed after 72 hours. Pickled product washed thoroughly before cutting for subsampling.

To make the bran-salt-pickled product, the daikon was placed in pickling crock and salt equal to 5 percent of its weight sprinkled over layers of daikon. Weighted down with a round board placed over the top. Daikon mixed once daily and removed after 72 hours. Brine discarded and unwashed daikon weighed. An amount of salt equal to 4 percent and rice bran equal to 50 percent of this weight mixed and placed in alternate layers with the daikon in the crock. Mixed once a day and allowed to pickle 1 week. Pickled product washed thoroughly before cutting for subsampling. (Takuan is the Japanese term for bran-salt-pickled daikon.) Weight loss: salt-pickling, 50 percent; bran-salt-pickling, 77 percent. Waste (ends and spoiled parts), 1 percent.

Sample 3. Commercial salt-pickled daikon totaling $1\frac{3}{4}$ pounds E.P. obtained from the market. Chopped before subsampling for B vitamins. No waste.

Egg: Analyzed raw only. Two dozen eggs obtained from the Station Poultry Farm. Twelve eggs mixed for analysis on the whole egg; and 12 eggs separated for yolk and white samples. Riboflavin and niacin determined. Later, 12 cracked, fresh eggs of assorted sizes from the same source as above obtained for thiamine analysis (the hard outer shells were cracked, but the inner membranes were still intact). Six eggs mixed for analysis on the whole egg and six eggs separated for yolk and white samples. Later, carotene and vitamin A determined on a sample of yolks from eight freshly laid eggs obtained from the Station Poultry Farm. The yolks were blended together slightly before sampling.

Eggplant (*Solanum melongena*): Analyzed raw and cooked.

Long: Molokai Long variety.

Sample 1. Six fruit totaling 1⅓ pounds from the Station Farm, Manoa Valley. Size range, 8½ to 9½ inches long; fruit firm and skin dark purple. Three fruit each for raw and cooked samples. Raw sample chopped before subsampling. Sample for cooking cut into 2-inch pieces, unpared, steamed 20 minutes, and blended. B vitamins determined. Waste (stems and calyxes), 6 percent. Later, carotene determined on eight fruit totaling 2¼ pounds obtained from a wholesaler. Size range, 7 to 12 x 1 to 1¾ inches. Fruit split lengthwise for raw and cooked samples. Raw sample chopped and blended before subsampling. Sample for cooking cut into ¼-inch slices and steamed 15 minutes. Waste (stems and calyxes), 10 percent. Ascorbic acid determined on nine fruit purchased on the market of same general description as above. Fruit split lengthwise for raw and cooked samples. Raw sample coarsely cut and mixed before subsampling. Sample for cooking cut into ½-inch pieces, steamed 20 minutes, and blended. Waste (stems and calyxes), 5 percent.

Sample 2. Analyzed (a) raw, (b) salt-pickled, and (c) bran-salt-pickled. Sample, 64 eggplants totaling 10 pounds purchased on the market. Size range, 5 x 1¼ to 9½ x 1½ inches; of good quality. All vitamins determined. Two pounds used for raw sample, and 4 pounds each for salt- and bran-salt-pickling.

To make the salt-pickled product, the fruits were rolled gently on a smooth surface to soften them slightly, then the eggplant was placed in pickling crock, and salt equal to 5 percent of its weight sprinkled over layers of eggplant. Weighted down with a round board placed over the top. Eggplant mixed once daily and removed after 72 hours. Pickled product washed thoroughly before cutting for subsampling.

To make the bran-salt-pickled product, the fruits were rolled gently on a smooth surface to soften them slightly (it was necessary to split the eggplants lengthwise for proper pickling to occur); placed in alternate layers in a pickling crock with a bran-salt paste (119 grams rice bran, 21 grams table salt, 210 grams water per 100 grams eggplant, made into a paste); mixed each day, and left 72 hours. The fruit were washed carefully to remove all traces of the paste before cutting for subsampling. Waste loss: salt-pickling, 26 percent; bran-salt-pickling, 20 percent. Waste (stems and calyxes), 3 percent.

Sample 3. Commercial salt-pickled eggplant totaling 1⅔ pounds E.P. purchased on the market. Coarsely cut before subsampling for B vitamins and carotene. No waste.

Round: New Hampshire Hybrid variety.

Six fruit, 4⅓ pounds from the Station Farm, Manoa Valley (sample 1). Size range, 3 to 4½ inches long. Three fruit each for raw and cooked samples. Sample for cooking sliced unpared, steamed 20 minutes, and blended. Raw sample chopped before subsampling. Waste (stems and calyxes), 7 percent. Later, two more lots of eggplant (samples 2 and 3) of four fruit and of three fruit purchased and analyzed separately. Average size, 5½ x 4½ inches; firm and fresh. Divided for raw and cooked samples. Raw sample chopped and blended. Samples for cooking cut into quarters unpared and sliced; steamed 20 minutes and blended. Waste (stems and calyxes), 4 percent. The values for thiamine are averages of data from samples 1 and 3; riboflavin the first sample only; niacin all three samples; and carotene the second sample only.

Ascorbic acid determined on three fruit (sample 4) totaling 1¾ pounds purchased on the market. Same general description as above. Fruit quartered, divided for raw and cooked samples, and cut into ½-inch slices unpared. Cooked by steaming for 20 minutes and blended. Waste (stem ends), 4 percent.

Figs (*Ficus carica*): Analyzed raw only. Sample, 2 pounds Brown Turkey variety obtained from a tree in Manoa Valley. Average size, 2¼ x 2⅛ inches; total sample blended before subsampling for B vitamins and carotene. Waste (stems), 2 percent. Ascorbic acid value from TB 6.

Goa or Winged Bean (*Psophocarpus tetragonolobus*): Analyzed raw and cooked. Sample, 3 pounds purchased on the market. Size range, 5 x ¾ to 6½ x 1 inches; of good quality. Sample for cooking cut into 1½- to 2-inch pieces, and steamed 15 minutes. B vitamins determined. Waste (ends and bruised portions), 8 percent. Later, carotene determined on a 1-pound sample purchased on the market. Size range, 4½ x 1¼ to 6¼ x 1⅛ inches. Prepared as above. Waste (ends and bruised portions), 6 percent. Ascorbic acid values from TB 6.

Gourd, White Flowered (*Lagenaria vulgaris, leucantha*): Analyzed raw and cooked. Sample, three gourds totaling 5 pounds purchased on the market. Size range, 11 x 3½ to 13 x 3½ inches; skin white to light green; of good quality. Cut in halves for raw and cooked samples. Raw sample pared and coarsely cut before subsampling. Sample for cooking pared, quartered, cut into 1-inch slices, and steamed 15 minutes. Thiamine, riboflavin, and ascorbic acid determined. Waste (skins, seeds, and stems), 20 percent. Later, niacin determined on two gourds totaling 3¾ pounds purchased on the market of same general description. Quartered and opposite quarters used for raw and cooked samples. Prepared in the same manner as above. Waste (skins, seeds, and stems), 27 percent.

Gourd, Dishcloth (*Luffa acutangula*): Analyzed raw and cooked. Sample, 2¾ pounds purchased on the market. Size range, 8 x 1½ to 9 x 2 inches; young, tender gourds. Total divided for raw and cooked samples; ribs and skins removed. Raw sample coarsely cut and mixed before subsampling. Sample for cooking cut into ½-inch slices and steamed 15 minutes. B vitamins and carotene determined. Waste (ribs and skins), 36 percent. Later, five gourds totaling 1½ pounds purchased on the market for ascorbic acid analysis. Same general description as above. Gourds pared and halved for raw and cooked samples. Quartered, sliced ¼ inch thick, steamed 15 minutes, and blended. Waste (ribs and skins), 28 percent.

Grapes, Isabella (*Vitis labrusca*): Analyzed raw only. Sample, 16 bunches, 30 to 40 grapes per bunch, totaling 3 pounds, Oahu grown. Average size, ¾ x ⅝ inch. Sample divided for separate analysis on whole, and with skins and seeds removed. B vitamins and carotene determined. Waste (stems), 2 percent; (skins, stems, and seeds), 31 percent. Ascorbic acid values from TB 6.

Guava: Analyzed raw only.

Cattley, Red or Strawberry (*Psidium Cattleianum*): Sample, 1 pound from a tree on Tantalus. Size range, ⅝ to 1 inch in diameter; only dark-red fruit used. Pulp scooped out from fruit and seeds removed by pressing through sieve. Pulp and shells combined and blended for B-vitamin assays. Waste (ends and seeds), 17 percent. Later, 1½ pounds picked in the Koolau foothills near Laie for carotene analysis. Size range, ⅝ to 1¼ inches in diameter; whole fruit used. No waste. Ascorbic acid value from TB 6.

Cattley, Yellow (*Psidium Cattleianum* var. *lucidum*):

Sample 1. 3⅓ pounds picked in Manoa Valley and refrigerated 2 days until assayed. Size range, ¾ to 1 inch in diameter; small round fruit; small bruised areas removed. Pulp scooped out from fruit and seeds removed by pressing through sieve. Pulp and shells combined and blended. Waste (stem and bud ends, seeds, and bruised areas), 28 percent.

Sample 2. One pound from same source and prepared as above, assayed immediately for ascorbic acid only. Size range, 1 to 1½ inches in diameter. Waste (seeds, stem and bud ends), 13 percent.

Common (*Psidium guajava*):

Sample 1. Twelve fruit totaling 2 pounds from the Station Farm, Poamoho, Oahu. Size range, 1¾ to 2½ inches long; sour, fairly small, red inside. Seeds removed by pressing pulp and seeds through sieve. Pulp and shells combined and blended for B-vitamin assays. Waste (ends and seeds), 22 percent. Later, nine guavas of same description and source obtained for carotene analysis. Prepared in the same manner. Waste (ends and seeds), 25 percent.

Sample 2. Six fruit totaling 2½ pounds from the Station Farm, Poamoho, Oahu. Size range, 2¼ to 3¼ inches long; white inside, yellow outside, fairly sweet. Some fruit fairly large, but badly stung by fruit fly. Prepared for analysis in the same manner as above for B-vitamin assays. Waste (ends, seeds, and spoiled sections), 24 percent. Later, 10 fruit of same description (better quality) and source obtained for carotene analysis. Prepared in the same manner. Waste (ends and seeds), 17 percent.

Sample 3. Six fruit totaling 2½ pounds from the Station Farm, Poamoho, Oahu. Size range 2¾ to 3¾ inches long; pink inside, green outside; large fruit, fairly sweet, but badly stung by fruit fly. Prepared for analysis in the same manner as above for B-vitamin assays. Waste (ends and seeds), 13 percent. Later, nine guavas of same description (fair quality) and source obtained for carotene analysis. Prepared in the same manner. Waste (ends, bruised areas, and seeds), 20 percent.

Sample 4. Seventeen fruit totaling 3¾ pounds from the Station Farm, Poamoho, Oahu. Size range, 2 x 1⅝ to 2½ x 2⅝ inches; pink inside and yellow outside. The whole fruit cut into sections and B vitamins determined. The seeds were part of the sample, but did not break during the analyses. Waste (ends), 4 percent. Later, seven guavas of same description obtained for carotene analysis from Manoa Valley. Three fruit kept at room temperature overnight until ripe; four refrigerated overnight. Prepared in same manner. Waste (ends), 1 percent. Ascorbic acid values for whole common guava with seeds from TB 6.

Special ascorbic acid studies: Samples of common guavas picked from trees in Manoa Valley used for studies of: (1) ascorbic acid distribution in rind and pulp, (2) stability of ascorbic acid at room temperature, (3) ascorbic acid of guava juice and remaining pulp, and (4) effect of refrigerated storage on guava juice (see pp. 40–45 for details).

Horseradish Tree (*Moringa oleifera*): Analyzed raw and cooked.

Leaflets and tender tips: Sample, 1 pound picked from a tree in Manoa Valley. Tender leaflets were stripped from stems and added to tips; stems were discarded. Cooked by steaming 15 minutes. B vitamins determined. Waste (stems), 26 percent. Later, ½ pound of same description and source used for carotene analysis. Waste (stems), 26 percent. Ascorbic acid values from TB 6.

Pods: Sample, 36 pods, 4 pounds picked from a tree in Manoa Valley. Size range, 12 to 20½ x ¼ to ⅞ inches. All hard outer coverings and fibers removed. Sample for cooking cut into 3-inch pieces, steamed 15 minutes, and blended. B vitamins determined. Waste (outer coverings and fibers), 34 percent. Later, sample of 1 pound of same description and source used for carotene analysis. Waste (outer coverings and fibers), 52 percent. Ascorbic acid values from TB 6.

Java Plum (Jambolan) (*Eugenia cumini*): Analyzed raw only. Sample,

$8\frac{3}{4}$ pounds picked in Manoa Valley. Average size, $1\frac{1}{8} \times \frac{7}{8}$ inches; purple skin and white flesh; of good quality. Pitted and blended before subsampling for thiamine and niacin. Waste (pits), 20 percent. Later, 4 pounds from the same source used for riboflavin and carotene analyses. Prepared in the same manner as above. Waste (seeds), 18 percent. Ascorbic acid value from TB 6.

Jute (Filipino Spinach) (*Corchorus olitorius*): Analyzed raw and cooked. Sample, three bunches totaling $2\frac{3}{4}$ pounds grown in Waianae, purchased on the market. Cooked by steaming 10 minutes and chopped before subsampling. B vitamins determined. Waste (tough stems and spoiled leaves), 26 percent. Later, 1 pound purchased on the market for carotene analysis. Only tender tips used. Waste (tough stems and leaves), 51 percent. Ascorbic acid values from TB 6.

Ketambilla (Ceylon Gooseberry) (*Dovyalis hebecarpa*): Analyzed raw only. Sample, $2\frac{1}{3}$ pounds, Oahu grown. Average size, $\frac{3}{4} \times \frac{7}{8}$ inch; some very ripe, some slightly green. Total blended before subsampling for all vitamins. Waste (bud ends), 1 percent.

Kombu, Kelp (*Laminariaceae*): Analyzed raw and cooked. Sample, 2 pounds E.P. dry weight (in $\frac{1}{2}$-pound packages, packed in Japan) purchased on the market. All leaves washed once and wiped dry. Sample for cooking, soaked in three times its weight of water for 30 minutes, drained, and steamed for 45 minutes. Both samples chopped before subsampling for thiamine and niacin determinations. Later, two 6-ounce packages purchased on the market for riboflavin, carotene, and ascorbic acid analyses. Size range: unwashed, 44 to 56 inches long; washed, $44 \times 3\frac{1}{4}$ to 59×2 inches. Total sample washed and dried; leaves split lengthwise for raw and cooked samples. Sample for cooking prepared as above.

The B vitamins and ascorbic acid were also determined on the water used in soaking the kombu prior to cooking.

Kumquot (*Fortunella* spp.): Analyzed raw only. Sample, nine fruit, $\frac{1}{4}$ pound, grown in Honolulu. Size range, $1\frac{1}{8} \times 1$ to $1\frac{1}{2} \times 1\frac{1}{8}$ inches; color greenish-yellow to orange. Skins, pulp, and membranes used for ascorbic acid analysis only. Waste (seeds), 2 percent.

Lettuce (*Lactuca sativa*): Analyzed raw only.

Head (Iceberg variety): Sample, three heads totaling $3\frac{3}{4}$ pounds grown on the island of Hawaii, obtained from wholesaler. Solid, well-rounded heads trimmed and ready for market. Chopped before subsampling for B-vitamin assays. Waste (outer leaves and bases), 14 percent. Later, two heads totaling $2\frac{1}{3}$ pounds grown on the Island of Hawaii, purchased on the market for carotene analysis. Size range, $4\frac{1}{2} \times 4\frac{1}{2} \times 3\frac{1}{2}$ to $5 \times 5 \times 4$ inches. Opposite quarters used for analysis. Waste (bases), 2 percent. Ascorbic acid determined on three heads totaling $4\frac{1}{3}$ pounds obtained from a wholesaler. Good fresh quality. Sections from each head coarsely cut and mixed before subsampling. Waste (outside leaves and bases), 8 percent.

Manoa: Sample, eight heads totaling $1\frac{3}{4}$ pounds purchased on the market. Size range, 5 x 4 to $5\frac{1}{2}$ x 4 inches; good fresh quality. Leaves broken into fourths and mixed before subsampling for B vitamins and carotene. Waste (bases), 9 percent. Ascorbic acid value from TB 6.

Lemon Juice (*Citrus limon*): Analyzed raw only. Sample, seven fruit totaling 2 pounds grown at Kona, Hawaii, Eurika variety, purchased on the market. Average size, $2\frac{3}{4}$ x $2\frac{5}{8}$ inches; greenish-color skin. Used for ascorbic acid analysis; juice strained through one layer cheesecloth. Waste (seeds, rinds, and coarse pulp), 58 percent.

Lime Juice (*Citrus aurantifolia*): Analyzed raw only. Sample, $2\frac{3}{4}$ pounds, Mexican variety, purchased on the market. Size range, $1\frac{1}{4}$ to $1\frac{3}{4}$ inches in diameter. Juice filtered through one layer of cheesecloth. B vitamins determined. Waste (seeds, rinds, and coarse pulp), 53 percent. Later, ascorbic acid determined on 37 fruit totaling 2 pounds, Oahu grown, Kusaie variety, purchased on the market. Size range, $1\frac{1}{4}$ x 1 to $1\frac{3}{4}$ x $1\frac{3}{4}$ inches. Prepared as above. Waste (seeds, rinds, and coarse pulp), 62 percent. Ascorbic acid values for other varieties from TB 6.

Lotus Root (*Nelumbium nelumbo*): Analyzed raw and cooked. Sample, two roots, with three lobes each, totaling $3\frac{1}{3}$ pounds, Oahu grown, obtained from wholesaler. Size range lobes, 3 to $6\frac{1}{2}$ x $1\frac{1}{4}$ to $2\frac{3}{4}$ inches. Lobes pared and halved crosswise, for raw and cooked samples. Cooked by steaming for 30 minutes. Samples blended before subsampling for B-vitamin assays. Waste (parings), 16 percent. Later, four lobes, from three roots, totaling 2 pounds, purchased on the market, used for ascorbic acid analysis. Size range lobes, 8 to $8\frac{3}{4}$ x $1\frac{1}{2}$ to $2\frac{1}{2}$ inches. Pared and split lengthwise for raw and cooked samples. Cut into $\frac{1}{4}$- to $\frac{1}{2}$-inch sections, steamed 30 minutes, and blended. Waste (parings), 8 percent.

Lychee (*Litchi chinensis* Sonn.) Brewster variety: Analyzed raw only. Sample, $3\frac{1}{2}$ pounds from the Station Farm, Poamoho, Oahu. Only fully mature fruit used for B vitamins. Waste (shells and seeds), 40 percent. Ascorbic acid value is an average of data on two separate samples, of 9 and 13 fruit each, obtained from same source as above, 1 year apart.

Macadamia Nuts (*Macadamia ternifolia*, F. Muell.): Samples of raw and roasted nuts obtained from a Honolulu processing plant. Salt wiped from roasted nuts. Cut and mixed before subsampling for B vitamins.

Malabar Nightshade (*Basella rubra*): Analyzed raw and cooked. Sample, $3\frac{1}{4}$ pounds purchased on the market; only 4 to 7 inches of tender tips used; of fresh quality. Cut into 2- to 3-inch lengths and steamed 15 minutes. B vitamins determined. Waste (overmature leaves, bruised portions, and tough stems), 3 percent. Later, $1\frac{1}{2}$ pounds purchased on the market same day as received from the grower for carotene analysis. Size range, 14 to 16 inches long; tender tips and leaves measuring 6 to 8 inches were used. Cooked by steaming 15 minutes.

Waste (tough stems, overmature and bruised leaves), 42 percent. Ascorbic acid values from TB 6.

Mango (*Mangifera indica*): Analyzed raw only.

Bishop: Sample, three fruit totaling 2½ pounds obtained from the Station Farm, Poamoho, Oahu. Picked mature green and allowed to ripen in the dark. When determined, two not fully ripe, and one very ripe. Blended before subsampling for B vitamins. Waste (seeds and skins), 25 percent. Ascorbic acid value from TB 6.

Common, green: Sample, four fruit totaling 1½ pounds from a tree near the University campus. Size range, 2¾ to 3¼ inches long. Peeled and blended before subsampling for B vitamins. Waste (seeds and skins), 40 percent. Ascorbic acid value from TB 6.

Common, ripe: Sample, four fruit totaling 1 pound picked from a tree near the University campus. Average size, 2½ inches long. Peeled and blended before subsampling for B vitamins. Waste (seeds and skins), 43 percent. Carotene determined on three fruit from the Station Farm, Poamoho, Oahu. Average size, 4 x 2½ x 2½ inches. Waste (skins and seeds), 41 percent. Ascorbic acid value from TB 6.

Common, special ascorbic acid studies, see pages 45 to 48:

Sample 1. Six half-ripe fruit totaling 2½ pounds purchased on the market for ascorbic acid stability studies. Divided into lots of three fruit each for two separate assays. Waste (skins), 15 percent; (seeds), 16 percent.

Sample 2. Five ripe fruit totaling 1¾ pounds from trees in Manoa Valley. Picked slightly green, and kept at room temperature until completely ripened. Used for ascorbic acid stability studies. Waste (skins), 22 percent; (seeds), 26 percent.

Haden: Two samples, three fruit, each sample totaling 2 pounds obtained from the Station Farm, Poamoho, Oahu, and from Kauai. Size range, 3 to 4½ inches long; picked mature green and allowed to ripen in the dark. Peeled and blended before subsampling. Riboflavin and niacin values are averages of data on both samples and thiamine of the Oahu sample only. Carotene determined on three fruit obtained from the Station Farm, Poamoho, Oahu. Mature but firm fruit of good quality. Waste (skins and seeds), 26 percent.

Ten mangos were individually assayed for their ascorbic acid content (see table 11). Waste (skins), 16 percent; (seeds), 9 percent. The ascorbic acid value in table 1 is an average of data on these samples.

Pirie: Sample, seven fruit totaling 3 pounds obtained from the Station Farm, Poamoho, Oahu. Size range, 3 to 3½ inches long; picked mature green and allowed to ripen in the dark. Peeled and blended before subsampling for B vitamins. Waste (skins and seeds), 33 percent. Carotene determined on three fruit from the same source. Waste (skins and seeds), 26 percent. Ascorbic acid value from TB 6.

Joe Welch: Sample, three fruit totaling 2 pounds obtained from the Experiment Station, H.S.P.A., Molokai. Average size, 3½ x 3 x 2¾ inches, mature and of good quality. Peeled and blended before subsampling for carotene analysis only. Waste (skins and seeds), 20 percent.

Ten mangos obtained from the same source were individually assayed for their ascorbic acid content (see p. 45). Size range, 3½ x 3½ to 4¼ x 3¾ inches. The ascorbic acid value in table 1 is an average of data on these samples. Waste (seeds), 9 percent; (skin), 13 percent.

Ascorbic acid values of other mango varieties than those named above from TB 6. (See p. 46.)

Melon, Chinese Preserving (*Benincasa cerifera*): Analyzed raw and cooked.

Large: Sample, half of one melon freshly cut crosswise (weight, whole 5½ pounds) purchased on the market. Pared, quartered, and opposite quarters used for raw and cooked samples. Sample for cooking cut into ¼-inch slices and steamed 30 minutes. B vitamins determined. Waste (parings, seeds, and core), 21 percent. Later, another half melon purchased on the market for ascorbic acid analysis (weight, whole 7½ pounds). Size, 11 (original length) x 5¾ inches; good quality; skin all white to white speckled with green. Pared, quartered, and opposite quarters used for raw and cooked samples. Sample for cooking cut into ¼-inch slices, steamed 30 minutes, and blended. Waste (parings, seeds, and core), 28 percent.

Small: Sample, two melons totaling 4¼ pounds purchased on the market. Size range, 5¾ x 3¾ to 6¼ x 4 inches; of good quality. Fuzz scraped off and melons halved for raw and cooked samples. Sample for cooking cut into 1-inch cubes and steamed 20 minutes. All vitamins determined. Waste (stems, fuzz, and bruised areas), <1 percent.

Milk: Analyzed raw and pasteurized. One quart each of raw and pasteurized milk taken from the same lot of milk from the University Dairy. B vitamins determined. Later, carotene and vitamin A determined on a 1-quart sample of freshly pasteurized homogenized milk obtained directly from a commercial creamery. Ascorbic acid values from TB 6.

Miso:

Sample, two 2-pound cartons purchased from the factory labeled "Shiro Koji Miso." Ingredients, soybeans, koji (fermented rice), and salt. Thiamine and niacin determined. Later, a 14-ounce jar purchased on the market for riboflavin analysis. Carotene determined on a 2-pound carton purchased on the market.

Sample, a 3-pound carton purchased from the factory labeled "Shiro White Miso." Ingredients, koji (fermented rice), soybeans, and salt. Thiamine and niacin determined. Later, a 14-ounce jar purchased on the market for riboflavin analysis. Carotene determined on a 2-pound carton purchased on the market.

Mountain Apple (*Eugenia malaccensis*): Analyzed raw only. Sample, 3 pounds picked from trees in Manoa Valley purchased on the market. Size range, $1\frac{1}{2} \times 1\frac{1}{4}$ to $2 \times 1\frac{1}{2}$ inches; firm, dark-red apples. Coarsely sectioned before subsampling for thiamine and niacin assays. Waste (seeds and ends), 14 percent. Riboflavin determined on 12 apples totaling 1 pound, same source and description as above. Waste (seeds and ends), 15 percent. Ten fruit from Nuuanu Valley used for ascorbic acid analysis of same general description as above; kept at room temperature for 2 days to ripen, and refrigerated overnight. Waste (seeds and ends), 12 percent.

Mulberry (*Morus nigra*): Analyzed raw only. Sample, 1½ pounds obtained from a home garden, Makiki District, Honolulu. Fruit with very small unripe areas not discarded. Total sample blended before subsampling for all vitamins.

Ohelo Berries (*Vaccinium reticulatum*): Analyzed raw only. Sample, 2⅓ pounds grown in the Hawaii National Park, received air freight. Size range, ¼ to ½ inch in diameter; of good quality. All vitamins determined. Ascorbic acid value from TB 6.

Okra (*Hibiscus esculentus*): Analyzed raw and cooked. Sample, 20 pods totaling ½ pound from the Station Farm, Manoa Valley. Size range, 4 to 5 inches long. Ten pods each for raw and cooked samples. Sample for cooking cut into ⅜-inch slices, steamed 20 minutes, and chopped. Thiamine and riboflavin determined. Waste (stems and tips), 18 percent. Later, 2 pounds, Oahu grown, purchased on the market for niacin and carotene analyses. Size range, $1\frac{3}{4} \times \frac{3}{4}$ to $4\frac{7}{8} \times \frac{7}{8}$ inches; good fresh quality, young and tender pods. Cut into ½-inch crosswise slices, mixed, and divided for raw and cooked samples. Cooked by steaming 20 minutes. Waste (tips and stems), 15 percent. Ascorbic acid values from TB 6.

Onions:

Dry (*Allium cepa*): Analyzed raw and cooked. Sample, 3 pounds, Maui grown, purchased on the market. Size range, $1\frac{3}{4} \times 2\frac{1}{4}$ to $1\frac{1}{2} \times 3$ inches. Onions quartered, mixed, and divided for raw and cooked samples. Cooked by steaming for 15 minutes. B vitamins determined. Waste (ends and outer dry skins), 9 percent. Later, eight onions, 2 pounds purchased on the market for ascorbic acid analysis. Of same description as above. Cut into halves for raw and cooked samples. Sample for cooking cut into ½-inch sections and steamed 15 minutes. Waste (ends and outer dry skins), 4 percent.

Green (*Allium fistulosum*): Analyzed raw and cooked. Sample, 2¼ pounds purchased on the market. Size range, 18 to 20 inches long; fresh quality; both white and green portions used. Raw sample coarsely cut before subsampling. Sample for cooking cut into 1-inch sections, steamed 5 minutes, and blended. B vitamins and carotene determined. Waste (roots and tough outer layers), 10 percent. Later, a 2-pound sample of same general description purchased for ascorbic acid analysis. Raw sample cut into 2-inch sections and mixed before subsampling. Sample for cooking cut into 1-inch pieces and steamed 5 minutes.

Opihi (*Helcioniscus exaratus* Nuttal and *H. argentatus* Sowerby): Analyzed raw only. Sample, 5 pounds purchased at a fish market, received by them day previously. E.P. removed from shells. Viscera separated from foot and mantle to make two samples which were weighed and analyzed separately for B vitamins. Later, carotene and vitamin A determined on 3 pounds prepared as above. Data on vitamin content of the whole was calculated from the weights and separate assays on the two portions. Waste (shells), 62 percent and 63 percent.

Orange, Hawaii (*Citrus sinensis*): Analyzed raw only. Sample, seven fruit, 3 pounds purchased on the market. Size, 3 x 3½ inches. Peel and membranes removed from sections before blending. B vitamins and carotene determined. Waste (peel and membranes), 42 percent. Later, ascorbic acid determined on five fruit totaling 1½ pounds, Kona, Hawaii grown, purchased on the market. Peel, pale orange-yellow; pulp, rather pale yellow and somewhat sour. Average size, 2¼ x 2¾ inches. Prepared as above. Waste (peel and membranes), 48 percent.

Papaya (*Carica papaya*): Analyzed raw only.

Common variety: Sample, one large fruit from a tree on the University campus. Picked and allowed to completely ripen before blending and subsampling for B vitamins. Ascorbic acid value is an average of individual determinations on eight fruit, longitudinal sections from opposite sides of each fruit making a total of 16 separate analyses.

Common variety, special ascorbic acid study: Sample, five large fruit picked at two different times from the same source as above. The bud, center, stem, and longitudinal sections of each fruit formed separate samples for ascorbic acid analysis. See page 49 for details.

Solo variety, hermaphrodite form: Two separate samples determined 5 years apart.

Sample 1. Four fruit totaling 2½ pounds from the Station Farm, Poamoho, Oahu. Size range, 4½ to 5½ inches long. Blended before subsampling. Waste (skins and seeds), 43 percent.

Sample 2. Five fruit totaling 5¼ pounds purchased on the market. Prepared as above. Waste (skins and seeds), 45 percent. The thiamine, riboflavin, and niacin values are averages of data on both samples and carotene on the second sample only. Ascorbic acid value from TB 6.

Solo variety, hermaphrodite form, special ascorbic acid study: Sample, three fruit of same general description as above purchased on the market. Used in the study of stability of ascorbic acid in papaya to standing at room temperature. From the same fruit, the ascorbic acid of the seeds and aril was determined. In addition, another sample of four fruit used to determine the effect of baking and preparation of papaya sauce upon the ascorbic acid content of papaya. See pages 48 to 49 for details.

Solo variety, pistillate form: Sample, four fruit totaling 3¼ pounds from the Station Farm, Poamoho, Oahu. Size range, 3½ to 4 inches long. Blended before subsampling for B vitamins. Waste (skins and seeds), 34 percent.

Passion Fruit (*Passiflora edulis*): Analyzed raw only.

Purple (*lilikoi*): Sample, 5½ pounds obtained from Kauai. Size range, 1¾ x 1½ to 2 x 1⅞ inches. Partially ripe fruit stored until shells turned purple. Pulp and seeds scooped out and squeezed through two layers of cheesecloth. All vitamins determined. Waste (shells), 44 percent; waste (pulp and seeds), 20 percent.

Yellow (var. *flavicarpa*): Sample, 63 fruit, 6 pounds from the University Horticulture Department. Harvested over a 3-week period and refrigerated until analyzed. Bright yellow shells, some slightly wrinkled, others smooth. Pulp scooped out and squeezed through two layers of cheesecloth. B vitamins and carotene determined. Waste (shells and seeds), 60 percent. Ascorbic acid value from TB 6.

Pea, Chinese Edible Pod (*Pisum sativum* var. *macrocarpon*): Analyzed raw and cooked.

Dwarf Gray Sugar: Two 1-pound samples from the Station Farm, Manoa Valley, assayed separately within a month's time. Size range, 1¼ x ⅜ to 3¼ x ¾ inches. Samples for cooking steamed 10 minutes and blended. Waste (ends and strings), average 9 percent. Thiamine and riboflavin values are from data on the second sample only, and niacin values are averages of data on both samples. Later, carotene and ascorbic acid determined on a 1⅓-pound sample of the same source and preparation as above.

Mammoth Sugar: A 1-pound sample from the Station Farm, Manoa Valley, treated in the same manner as above. Riboflavin and niacin determined. Waste (ends and strings), 8 percent. Later, carotene determined on a ½-pound sample of same source and preparation as above, of fair quality. Separate samples from the same plants were obtained within 4 days for thiamine and ascorbic acid analyses (½- and 1-pound samples respectively). Source and preparation as above.

Pepper, Green Bell (*Capsicum frutescens*): Analyzed raw and cooked. Sample, 18 peppers, 5 pounds purchased on the market. Size range, 2⅝ x 2⅞ to 4⅜ x 2⅞ inches; fresh quality. Nine peppers each for raw and cooked samples. Raw sample chopped and blended. Sample for cooking cut crosswise into ¼-inch slices and steamed 15 minutes. Thiamine, riboflavin, and carotene determined. Waste (stems, seeds, and cores), 12 percent. Later, ascorbic acid and niacin determined on eight peppers totaling 2 pounds purchased on the market, of the same general description as above. Split lengthwise for raw and cooked samples. Sample for cooking prepared as above, blended before subsampling. Waste (stems, seeds, and cores), 16 percent.

Pigeonpeas, Green Shelled (*Cajanus cajan*): Analyzed raw and cooked. Sample, 2 pounds from the Station Farm, Waimanalo, Oahu. Size range of pods, 2 x ½ to 3 x ½ inches. Shelled and only good quality peas used. Cooked by steaming for 15 minutes. Thiamine, niacin, and carotene determined. Waste (pods), 50 percent. Later, another 2-pound lot of peas from the same source, description, and preparation as above used for riboflavin analysis. Ascorbic acid determined on a 1¾-pound sample from same source, description, and preparation as above. Waste (pods), 57 percent.

Pineapple (*Ananas comosus*): Analyzed raw only. Sample, three fruit, Cayenne variety, obtained from the Pineapple Research Institute. The plants had been treated with hormones. Cross-section slices taken from the three fruit and blended before subsampling for riboflavin and niacin assays. Waste (crowns, cores, and parings), 44 percent. Later, thiamine, carotene, and ascorbic acid assayed on three fruit from same source. No hormone treatment. Opposite longitudinal quarters used. Waste (cores and parings), 33 percent.

Pineapple Bran: Sample, for B vitamins and carotene analyses, obtained from the Animal Husbandry Department, University of Hawaii.

Plantains* (*Musa paradisiaca* subspecies *normalis*): Analyzed raw and cooked. All plantains were obtained from the same source and same area — the Station Farm, Poamoho, Oahu, but at different seasons. Raw samples were peeled and blended before subsampling. The samples for cooking were steamed in the skins for 20 minutes, peeled, and blended.

Iholena: Sample, 10 fruit totaling 3½ pounds from five hands of one bunch. Size range, 4 x 2 to 5¼ x 2¼ inches; fully ripe when used. Five fruit, each from a different hand, used for raw sample, and another five fruit for cooked sample. All vitamins determined. Waste (skins), 15 percent raw and 16 percent cooked.

Kahili Haa: Sample, 10 fruit totaling 3¼ pounds from one bunch. Size range, 4¾ x 1¾ to 5¼ x 1¾ inches. Ripe when received; thin skins and pink flesh. Five fruit each for raw and cooked samples. B vitamins determined. Waste (skins), raw 13 percent and cooked 15 percent. Later, six fruit from three hands of one bunch (three each for raw and cooked samples) were prepared for carotene and ascorbic acid analyses. Waste (skins), raw 17 percent and cooked 20 percent.

Moa or Huamoa: Sample, 12 fruit totaling 3⅓ pounds from one bunch. Kept at room temperature until ripe, and then in a cooler until analyzed. Size range, 4½ to 5½ inches long. Six fruit each for raw and cooked samples. B vitamins determined. Waste (skins), raw 27 percent and cooked 22 percent. Later, four fruit from same source obtained for carotene analysis. Kept at room temperature until ripe. Size range, 4¾ to 5¼ x 2 to 2¼ inches; of good quality, two fruit each for raw and cooked samples.

Popoulu: Sample, 10 fruit totaling 3 pounds taken from three hands of one

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* For definition of plantains, see footnote on page 35. The names for the plantains have not been thoroughly studied by horticulturists. Thus, some of the variety names listed may be synonymous.

bunch. Size range, $4\frac{1}{4} \times 1\frac{3}{4}$ to $4\frac{1}{4} \times 2\frac{3}{8}$ inches; flesh pinkish-yellow when raw. Five fruit each for raw and cooked samples. All vitamins determined. Waste (skins), raw 17 percent and cooked 15 percent.

Puapuanui: Sample, 12 fruit totaling $3\frac{1}{2}$ pounds taken from three hands of one bunch. Kept at room temperature until ripe. Size range, $4 \times 1\frac{7}{8}$ to $5 \times 2\frac{1}{4}$ inches. Six fruit each for raw and cooked samples. All vitamins determined. Waste (skins), raw 16 percent.

Plum, Methley (*Prunus Salicina* x *Cerasifera Myrobalana*): Analyzed raw only. Sample, 45 plums, 2 pounds, Kauai grown, purchased on the market same day shipment received in Honolulu. Size range, $1\frac{1}{8} \times 1\frac{1}{8}$ to $1\frac{1}{2} \times 1\frac{3}{8}$ inches; light to dark red color, firm, and fresh. Cut up coarsely, unpeeled, before subsampling for thiamine, niacin, carotene, and ascorbic acid. Waste (seeds and ends), 6 percent. Later, riboflavin determined on a 5-pound sample taken from a 40-pound lot received air freight from Kokee, Kauai. Prepared as above.

Poha (*Physalis peruviana*): Analyzed raw only. Sample, 1 pound grown on the island of Hawaii obtained from a wholesaler. Fruit husked and blended before subsampling for thiamine and riboflavin assays. Waste (husks), 8 percent. Later, a 2-pound sample from the same source used for niacin and carotene analyses. Size range, with husks, $1\frac{1}{4} \times \frac{7}{8}$ to $1\frac{1}{2} \times 1\frac{1}{8}$ inches; berries, $\frac{5}{8} \times \frac{5}{8}$ to $\frac{3}{4} \times \frac{3}{4}$ inch. Husked and blended before subsampling. Ascorbic acid value from TB 6.

Pomelo (*Citrus grandis* (L.) Osbeck): Analyzed raw only. Sample, two fruit totaling 7 pounds grown in Manoa Valley. Size range, $6\frac{1}{2} \times 5$ to $6 \times 6\frac{1}{2}$ inches; juicy and sour, not top quality. Fruit peeled, membranes removed, and sections blended before subsampling for riboflavin and niacin assays. Waste (peels, membranes, and seeds), 40 percent. Later, thiamine determined on three fruit totaling $8\frac{1}{2}$ pounds from the Station Farm, Poamoho, Oahu. Waste (peels, membranes, and seeds), 46 percent. Ascorbic acid from TB 6.

Potato (*Solanum tuberosum*): Analyzed raw and cooked. Sample, 12 tubers totaling $2\frac{3}{4}$ pounds, Kennebec variety, from the Station Farm, Manoa Valley. Picked and aged 1 week. Size range, $2\frac{1}{2} \times 1\frac{1}{3}$ to $4\frac{1}{2} \times 2\frac{1}{2}$ inches. Six potatoes each for raw and cooked samples. Sample for cooking boiled gently unpared in salted water 30 minutes. Peeled and blended. B vitamins determined. The cooking water was also analyzed for the three B vitamins. Waste (skins), raw 5 percent and cooked 2 percent. Ascorbic acid not determined.

Purslane (*Portulaca oleracea*): Analyzed raw and cooked. Sample, $1\frac{1}{2}$ pounds E.P. picked on the University campus. Cooked by steaming for 10 minutes and blended. B vitamins determined. No waste. Later, $2\frac{1}{3}$ pounds obtained from Makaha, Oahu, for carotene analysis. Fair quality, only 3 to 4 inches of tender tips used. Cooked by steaming for 10 minutes. Ascorbic acid values from TB 6.

Rice (*Oryza sativa*):

Bran: Used in the pickling studies. Subsamples taken from a 10-pound lot obtained locally. B vitamins determined.

Brown: Analyzed raw and cooked. Sample, 3 pounds, purchased on the market; removed by means of a grain sampler from a half-filled 100-pound sack. Rice shipped from California. The raw sample (300 grams) was ground to a fine meal (approximately 20 mesh) before subsampling. Sample for cooking (282 grams = 1½ cups raw rice) was prepared as follows: (1) 846 milliliters of distilled water (3 times the weight of the rice) was added to the rice, swirled ½ minute, and drained ½ minute; (2) the drained rice was put in a 3-quart saucepan with a tight-fitting lid, twice the amount of hot distilled water (3 cups) as the original measure of the rice added, and allowed to stand for 2 hours; (3) after the 2-hour interval, cooked by placing saucepan on a surface unit turned to high heat for 6 minutes (or until steaming freely), then turned to fourth unit (low) for 35 minutes; (4) surface unit turned off, but the pan was kept on the unit for 20 minutes more (*25*). B vitamins determined.

Converted, Long Grain: Sample, a 1-pound 12-ounce package purchased on the market for thiamine analysis, raw and cooked. Prepared in the same manner as brown rice.

Fortified: Sample, one 5-pound bag purchased on the market was used for all B-vitamin assays before and after 6 months of storage in the laboratory. The rice was analyzed (1) raw unwashed, (2) washed, and (3) washed and cooked. The raw unwashed rice (500 grams) was ground to a fine meal (approximately 20 mesh) before subsampling.

Rice was washed by the following method: (1) 1500 milliliters of distilled water (3 times the weight of the rice) was added to 500 grams of rice and left for 1 minute, drained ½ minute; (2) the drained rice was swirled in 1500 milliliters distilled water for ½ minute and drained ½ minute. The procedure given in (2) was repeated three more times to make a total of five washings. (Orientals customarily wash their white rice in four to seven changes of water.) The washed rice was allowed to dry at room temperature protected from the light for 3 days to facilitate grinding to a fine meal for subsampling.

Sample for cooking (309 grams = 1½ cups raw rice) was washed as above, then put in a 2½-quart saucepan with a tight-fitting lid, with an amount of distilled water (1½ cups) equal to the original measure of the rice. Cooked by placing saucepan on a surface unit turned to high heat for 10 minutes (or until steaming freely), then at medium heat for 6 minutes. Surface unit turned off, but the pan was kept on the unit for 10 minutes more (*5*).

After 6 months laboratory storage (original paper bag in can with tight-fitting lid), analyses of the raw rice were repeated as above.

Partially polished: Analyzed raw and cooked. Sample, 3 pounds removed by means of a grain sampler from a half-filled 100-pound sack.

Purchased at the same time and place as brown rice. Shipped from California already partially polished. The raw rice (300 grams) was ground to a fine meal in the laboratory (approximately 20 mesh) before subsampling. Sample for cooking (287 grams = 1½ cups raw rice) was prepared as follows: (1) 861 milliliters of distilled water (3 times the weight of the rice) added, swirled ½ minute, and drained ½ minute; (2) the drained rice was put in a 2-quart saucepan with a tight-fitting lid, and 1½ times the amount of distilled water (2¼ cups) as the original measure of the rice added; (3) cooked by placing saucepan on a surface unit turned to high heat for 5 minutes (or until steaming freely), then turned to fourth unit (low) for 10 minutes; and (4) surface unit turned off, but the pan kept on the unit for 20 minutes more (*25*). B vitamins determined.

Roselle (*Hibiscus sabdariffa*): Analyzed raw only. Sample totaling 6 pounds picked from bushes on the Station Farm, Manoa Valley. Size range, 1 x ¾ to 2 x 1¼ inches. Only the calyxes used. Cut before subsampling for all vitamin assays. Waste (stems and seed pods), 30 percent. Later, ascorbic acid determined on a 1-pound sample from the Station Farm, Manoa Valley. Same description and preparation as above. Waste (seed pods), 43 percent.

Sesbania Flowers (*Sesbania grandiflora*): Analyzed raw and cooked. Sample, 2 pounds purchased on the market. Good fresh quality white flowers. Cooked by immersing in boiling water until water returned to a boil (2½ minutes total). Waste (stems, calyxes, and pistils), 35 percent. B vitamins determined. Ascorbic acid values from TB 6.

Soursop (*Anona muricata*): Analyzed raw only. Sample, two fruit totaling 4 pounds grown in Honolulu. Size range, 5½ x 4½ to 8½ x 3½ inches; one fruit riper than the other. Fruit pulp first pressed through a colander to form a puree, then squeezed through a cheesecloth. B vitamins and ascorbic acid determined. Waste (thick skins, seeds, and coarse pulp), 50 percent.

Soybean, Green (*Glycine max*): Analyzed raw and cooked. Sample, 7 pounds each of two varieties, Sac and Rokusan A, from the Station Farm, Manoa Valley. Only young, tender, green beans used. Representative portions removed from the total for raw and cooked samples. Parboiled 5 minutes in shells, shelled, and boiled gently for 15 minutes in small amounts of water. Blended with residual cooking water before subsampling. B vitamins determined. Waste (pods), Sac, 59 percent; Rokusan A, 58 percent. Carotene determined on 1-pound samples of same source of generally fair quality and prepared as above. Later, 4½ pounds of each variety picked from same place for ascorbic acid analysis. Prepared in same manner as above.

Special study: Effect of three methods of cooking on the thiamine, riboflavin, and niacin content of green soybeans. For details, see page 51.

Soybean Products:

Aburage: Sample, 1½ pounds E.P. purchased on the market. Triangular shape. Coarsely cut before subsampling for B-vitamin assays. No waste.

Miso: Refer to page 77.

Special tofu study: Samples obtained from three factories were: (1) 1 pound dried soybeans; (2) 2 quarts *tonyu*, soybean milk, pressed from soaked, crushed soybeans, heated to the boiling point; (3) 2 pounds *kirazu*, residue remaining after soybean milk is expressed; (4) three blocks of *tofu*, soybean curd. All products were obtained from one factory on the same day. The dried soybeans were ground before subsampling (sample from factory number 1 ground only once, others ground 3 times). B vitamins determined. The averages of the values for the products from the three tofu factories are given in tables 1 and 12. For details of this study and individual values, see reference *24*.

Sprouts—see Bean Sprouts, Soy, and Bean Sprouts, Mung

Spinach, Chinese (Amaranth) (*Amaranthus spp.*): Analyzed raw and cooked. Sample, three bunches, 3⅓ pounds, Oahu grown, purchased on the market. Size range, 9 to 12 inches long. Divided for raw and cooked samples. Cooked by steaming for 10 minutes and blended before subsampling for riboflavin and niacin assays. Waste (roots, ½- to 1-inch stem above roots, and damaged leaves), 32 percent. Later, ⅔ pound purchased on the market for thiamine analysis. Cut into 1½-inch pieces, steamed 10 minutes, and blended. Waste same as above, 30 percent. Carotene determined on a 3-pound sample purchased on the market. Prepared in the same manner as the sample for thiamine. Waste, 14 percent. Ascorbic acid determined on 2 pounds purchased on the market. Fresh, with dark-green color. Sample for cooking cut into 2-inch lengths, steamed 10 minutes, and blended. Waste (roots and damaged areas), 13 percent.

Squash, Summer (*Cucurbita pepo*): Analyzed raw and cooked.

Pattypan: Sample, 3 pounds, Oahu grown, purchased on the market. Size range, 2¼ x 1½ to 2½ x 3 inches; young and tender. Sample for cooking quartered, sliced unpared into ¼-inch slices, and steamed 15 minutes. B vitamins and carotene determined. Waste (ends), 2 percent. Later, eight squash, 1 pound, purchased on the market for ascorbic acid analysis. Size range, 1½ x 1⅞ to 1½ x 2¾ inches; young, tender, and light-green color. Total cut into ¼-inch slices unpared, mixed, and divided for raw and cooked samples. Cooked by steaming for 15 minutes and blended. Waste (ends), 10 percent.

Zucchini: Sample, eight squash, 3 pounds grown in the Volcano region, Hawaii, obtained from a wholesaler. Size range, 5½ to 7 x 1¾ to 2¼ inches. Four squash each for raw and cooked samples. Cut into ⅜-inch slices unpared, steamed 15 minutes, and blended. B vitamins determined. Waste (ends), 4 percent. Carotene determined on five squash purchased on the market of the same general description as above. Squash split for raw and cooked samples. Raw sample thinly sliced and blended. Sample for cooking cut into ¼-inch slices and steamed 15 minutes. Waste (ends), 2 percent. Six squash, Oahu grown, purchased on the market for ascorbic acid analysis. Prepared in the same manner as the carotene sample. Waste (ends), 2 percent.

Squash, Winter Type or Pumpkin (*Cucurbita* sp. *Moschata* and *Maxima*): Analyzed raw and cooked.

Flowers: Sample, three bunches, 3¾ pounds purchased on the market. Size range, 4 to 5 inches long; of good quality. Divided for raw and cooked samples. Cooked by dipping in boiling water 1 minute. B vitamins determined. Waste (stems, calyxes, and pistils), 44 percent. Carotene determined on 1 pound, same source, description, and preparation as above. Waste (stems, calyxes, and pistils), 29 percent. Ascorbic acid values from TB 6.

Fruit:

Sample 1. Two winter squash (or pumpkin) totaling 6¾ pounds, Maui grown, obtained from a wholesaler. Size range, 3¼ inches deep, 6 to 7 inches in diameter; thin yellow skin; shape round and squat. Squash cut in half and a quarter of each unpared used for raw and cooked samples for riboflavin and niacin. Sliced, steamed 20 minutes, and blended. Waste (seeds, seed pulp, and stems), 5 percent. Later, thiamine, carotene, and ascorbic acid determined on two squash totaling 2⅔ pounds of same general description as above. Opposite quarters used for raw and cooked samples. Prepared as above. Waste (seeds, seed pulp, and stems), 16 percent.

Sample 2. Three squash (or pumpkin), 12¼ pounds, Maui grown, obtained from a wholesaler. Average size, 3 inches deep, 7 inches in diameter; skin hard and green; shape round and squat. Opposite halves used to form raw and cooked samples. Raw sample pared, chopped, and blended. Sample for cooking pared, sliced ¼ inch thick, steamed 20 minutes, and pressed through sieve. B vitamins and carotene determined. Waste (rinds, seeds, seed pulp, and stems), 20 percent. Ascorbic acid values from TB 6.

Leafy tender tips: Sample, two bunches, 2¼ pounds purchased on the market. Only tender sections used. Sample for cooking cut into 1½- to 2-inch pieces and steamed 10 minutes. B vitamins determined. Waste (less tender parts, fibers, and overmature leaves), 30 percent. Later, carotene determined on 1 pound purchased on the market of same description and preparation as above. Waste (tough stems and leaves), 62 percent. Ascorbic acid values from TB 6.

Strawberry (*Fragaria chiloensis*): Analyzed raw only. Sample, 2 pounds, Oahu grown, obtained from a wholesaler. Size range, ½ x ¾ to 1¼ x 1 inches; good quality red fruit. Coarsely cut before subsampling for all vitamins. Waste (stems, calyxes, and bruised spots), 17 percent.

Surinam Cherry (*Eugenia uniflora*): Analyzed raw only. Sample, two separate ¾-pound samples of cherries, Kanda variety, were obtained within 4 days time from the same trees, Station Farm, Poamoho. Average size, ⅞ x 1 inch; good quality; only darker-red fruits used. Riboflavin, niacin, and ascorbic acid were determined on one sample, and thiamine and carotene on the other. Waste (stems and pits), 19 percent.

Swamp Cabbage (*Ipomoea reptans*): Analyzed raw and cooked. Sample, three 1-pound bunches, Oahu grown, purchased on the market. Size range, 12 to 24 inches long. Divided into raw and cooked samples using only tender sections. Cut into 3-inch lengths, steamed 10 minutes, and blended. B vitamins determined. Waste (large tough stems), 14 percent. Later, 2 pounds purchased on the market for carotene analysis. Same general description as above; of good quality. Sample for cooking prepared in same manner. Waste (1- to 2-inch tough stems), 8 percent. Ascorbic acid values from TB 6.

Sweetpotato (*Ipomoea batatas*): Analyzed raw and cooked.

Sample 1. Five potatoes totaling 3¼ pounds, H.S.P.A. 3 variety, from the Station Farm, Waimanalo, Oahu. Harvested 2 weeks previously and kept 3 to 8 days at 80 to 85° F. Size range, 6 x 2 to 8¾ x 2½ inches. Three potatoes for raw sample chopped before subsampling; and two covered with boiling water and cooked for 40 minutes, peeled, and pressed through ricer. B vitamins determined. Waste (skins), raw 16 percent and cooked 11 percent. Carotene determined on another lot of four potatoes, two each for raw and cooked. Waste (skins), 18 percent, raw and cooked.

Sample 2. Six potatoes totaling 3½ pounds, Onolena variety, from the Station Farm, Waimanalo, Oahu. Same general description and treatment as Sample 1. Three potatoes each for raw and cooked samples, prepared as Sample 1 for B-vitamin determinations. Later carotene determined on another lot of potatoes, one each for raw and cooked samples. Six potatoes totaling 2¼ pounds from the same source obtained for ascorbic acid analysis. Three potatoes each for raw and cooked samples. Sample for cooking boiled as above (Sample 1) for 30 minutes. Waste (skins), raw 12 percent and cooked 7 percent.

Sample 3. Five potatoes totaling 3 pounds of unnamed seedlings from the Station Farm, Poamoho, Oahu. Size range, 5 to 7½ inches long; harvested 15 days before analyzing. Two potatoes used for raw sample; and three cooked in boiling water unpared for 45 minutes, peeled, and chopped before subsampling for B vitamins only. Waste (skins), raw 9 percent and cooked 8 percent.

Sweetpotato Tops (*Ipomoea batatas*): Analyzed raw and cooked. Sample, ½ pound E.P. of the two varieties, H.S.P.A. 3 and Onolena, from the Station Farm, Manoa Valley, analyzed separately. Tender sections formed the samples. Cooked by steaming for 15 minutes and blended. B vitamins determined. Later, 1-pound samples of each variety from the Station Farm, Manoa Valley, used for carotene analysis. Samples composed of 3 to 4 inches tender tips and leaves. Ascorbic acid values from TB 6.

Tamarind (*Tamarindus indica*): Analyzed raw only.

Green: Sample, 2½ pounds picked from trees on the University campus. Soft shells removed by paring. Total sample chopped and mixed before subsampling for all vitamins. Waste (soft shells), 41 percent.

Ripe: Sample, 9 pounds obtained from trees in Manoa Valley. Average size, 4 x 3/4 inches; of fair quality. Shelled and edible portion scraped off. Tough membranes around seeds discarded. B vitamins determined. Waste (shells, seeds, and tough membranes), 69 percent.

Taro Leaves (*Luau*) (*Colocasia esculenta* (L.) Schott): Analyzed raw and cooked.

Hawaiian, *Haokea:* Sample, 32 leaves, 1 pound obtained from a farm near Fort Shafter. Size range, 8 to 12 inches long. Seventeen leaves used for raw sample; and 15 cooked by steaming for 1 hour, and chopped. B vitamins determined. Waste (stems and heavy midribs), 18 percent. Carotene determined on a 1/2-pound sample, Oahu grown, purchased on the market. Size range, leaves, 9 x 7 to 14 x 12 inches. Stems and heavy midribs removed. Leaves split lengthwise for raw and cooked samples. Cooked by steaming for 1 hour. Waste (stems, heavy midribs, and bruised areas), 27 percent. Ascorbic acid values from TB 6.

Chinese, *Bun Long*: Sample, 50 leaves, 3/4 pound from the same source. Size range, 5 to 12 inches long. Raw sample, 24 leaves; cooked sample, 26 leaves steamed 1 hour, and chopped. B vitamins determined. Waste (stems and heavy midribs), 16 percent. Carotene determined on a 3 1/2-pound sample; same source, and preparation as above. Size range, 16 x 12 to 19 x 14 inches. Waste (stems and heavy midribs), 36 percent.

Taro Corms (*Colocasia esculenta* (L.) Schott):

Piko Kea: Analyzed raw and cooked. Sample, six corms, 5 1/2 pounds from the same source as taro leaves. Refrigerated 7 days before analyzed. Size range, 5 to 6 inches long. Three corms each for raw and cooked samples. Cooked 45 minutes at 15 pounds pressure unpared. Peeled and chopped. B vitamins determined. Waste (skins), raw 20 percent and cooked 26 percent. Ascorbic acid values from TB 6.

Piko Keokeo: Analyzed cooked only. Sample, four small corms totaling 1 1/4 pounds from same source. Refrigerated 7 days before analyzed. Size range, 3 1/2 to 4 1/2 inches long. Prepared in the same manner as Piko Kea. B vitamins determined. Waste (skins), 26 percent.

Chinese, *Bun Long*: Analyzed raw and cooked. Sample, six corms, 3 1/2 pounds obtained from the same source. Size range, 4 1/2 to 6 inches long. Three corms each for raw and cooked samples. Cooked and prepared in the same manner as Piko Kea corms. B vitamins determined. Waste (skins), 16 percent raw and 11 percent cooked.

Poi Factory Study: Taro Corms and *Paiai.*

Samples from factory number 1, five raw, five factory-cooked corms, and 5 pounds paiai. Raw and cooked corms chopped before subsampling. Paiai analyzed fresh only. B vitamins determined. Later, 1 1/2 pounds of paiai from another factory were obtained for carotene analysis.

Samples from factory number 2, five raw, five factory-cooked corms, and 5 pounds paiai. Corms treated as above. Paiai analyzed fresh only. B vitamins determined. Later, 2⅔ pounds of paiai from another factory were obtained for carotene analysis.

Samples from factory number 3, two raw corms, Kauai grown, two raw corms, Oahu grown, five factory-cooked corms mixed, and 5 pounds paiai. Treated in the same manner as samples from factory number 1. B vitamins determined. Later, five raw corms, five cooked corms, and 1¼ pounds of paiai from same source for carotene analysis. Size range corms, 3¾ x 2½ to 4½ x 2¾ inches. Taro obtained by factory from many sources. Ascorbic acid values for paiai from TB 6.

The averages of the values for the products from the three poi factories are given in tables 1 and 14. For details of this study and individual values, see reference *23*.

Taro, Japanese (Dasheen) (*Colocasia esculenta* var. *globulifera*): Analyzed raw and cooked. Sample, 11 corms, 2 pounds grown on the island of Hawaii, picked approximately 1 week before being analyzed. Size range, 2½ x 1¾ to 3 x 2 inches. Five corms for raw sample, chopped before subsampling; and six corms covered with boiling water and cooked 35 minutes. Peeled and chopped before subsampling for riboflavin and niacin assays. Waste (skins and stems), 11 percent raw and 5 percent cooked. Cooking water analyzed separately. Later, carotene determined on 10 corms totaling 1¼ pounds purchased on the market, of same general description as above. Five corms each used for raw and cooked samples, prepared as above. Thiamine determined on six corms of same general description. Three corms each for raw and cooked samples prepared as above. Ascorbic acid values from TB 6.

Tomato, Eggshaped (*Lycopersicon esculentum*): Analyzed raw only. Sample, 13 fruit, 1 pound purchased on the market. Size range, 1¾ x 1¼ to 2¼ x 1½ inches; of good quality. Individual weight range, 21 to 38 grams. Only ascorbic acid determined on unpeeled fruit.

Tomato, Globe (*Lycopersicon esculentum*): Analyzed raw only. Sample, eight fruit, 3 pounds, Kauai variety, from the Station Farm, Poamoho, Oahu. Kept refrigerated 2 days before analyzed. Size range, 2¼ to 3¼ inches in diameter; varied in color from light to deep red. Peeled and blended before subsampling for B vitamins. Waste (skins, stem ends, and unripe sections), 8 percent. Later, carotene and ascorbic acid determined on six fruit, 2½ pounds, of same variety and source as above. Kept at room temperature 4 days until completely ripened. Excellent quality. Peeled before subsampling. Waste (skins and stem ends), 8 percent.

Tree Fern Fronds (scientific name unknown): Analyzed cooked only. Sample, 2 pounds E.P. grown Punaluu, Oahu, purchased on the market. Received by the market 2 days before from farmer who had boiled and peeled them. Kept in jar covered with water. Pieces were 6½ x ½ to 9½ x ¾ inches. Color ranged from greenish-white to pinkish-brown. Some stalks appeared fibrous and tough, slimy on outside; others not so tough. Slightly fermented smell. B vitamins and carotene determined. No waste.

Turnip Greens (*Brassica rapa*): Analyzed raw and cooked. Sample, 3 pounds, Oahu grown, purchased on the market. Young and tender. Divided for raw and cooked samples. Sample for cooking cut into 2-inch pieces, and steamed 10 minutes. B vitamins and carotene determined. Waste (tap roots, bruised and insect-damaged areas), 27 per cent. Later, 1⅓ pounds purchased on the market for ascorbic acid analysis. Of same general description as above and prepared in the same manner. Waste (small turnips, bruised and insect-damaged areas), 18 percent.

Vi-Apple (*Spondias cytherea* Sonn. or *Spondias dulcis* Forst.): Analyzed raw only. Sample, eight fruit totaling 3 pounds picked from a tree in Honolulu. Size range, 2¼ to 3¼ inches long; picked green and kept at room temperature 1 week until fruit turned yellow. Fruit peeled, pitted, and blended before subsampling for B-vitamin assays. Waste (skins and pits), 27 percent. Later, 13 fruit from same source and of same description obtained for carotene and ascorbic acid determinations. Waste (skins, pits, and bruised spots), 41 percent.

Watercress (*Nasturtium officinale* R. Br.): Analyzed raw and cooked. Sample, two 1-pound bunches, Oahu grown, purchased on the market. Divided for raw and cooked samples. Cooked by steaming for 5 minutes and blended. B vitamins determined. Waste (thick stems), 35 percent. Carotene determined on a 3-pound sample refrigerated for 2 days prior to analysis. Prepared as above. Waste (tough stems), 18 percent. Ascorbic acid values from TB 6.

Watermelon (*Citrullus vulgaris*): Analyzed raw only. Sample, four 1-pound wedges from two melons, Kahuku grown, purchased on the market. Of good quality. Riboflavin and niacin determined. Waste (seeds and rinds), 33 percent. Later, three melons obtained from Waimanalo; wedges from same, totaling 4 pounds, used for thiamine and carotene analyses. Medium-size melons with green skin and black seeds. Waste (seeds and rinds), 42 percent. Ascorbic acid value from TB 6.

Yam Bean Root (*Pachyrhizus* spp.): Analyzed raw and cooked. Sample, four roots, 3½ pounds, purchased on the market. Size range, 3 x 3 to 5¼ x 5 inches. Sample for cooking pared, quartered, sliced ¼ inch thick, and steamed for 10 minutes. B vitamins determined. Waste (skins), 7 percent. Later, ascorbic acid determined on another four roots purchased on the market of same general description as above. Cut into halves for raw and cooked samples. Sample for cooking, pared, quartered, cut into ¼-inch slices, and steamed for 12 minutes. Waste (skins), 9 percent.

Yam, Polynesian (*Pi'ia*) (*Dioscorea pentaphylla* L.): Analyzed raw and cooked. Sample, six tubers totaling 4 pounds, collected by Dr. Harold St. John, Professor of Botany, University of Hawaii, growing wild 2 inches underground in Koolau Range at an altitude of 1,070 feet. Very irregular in size and shape. Size range (length x diameter at widest portion), $2\frac{1}{2}$ x $2\frac{1}{2}$ to 5 x $3\frac{1}{2}$ inches; one was round and others pear-shaped but with necks of variable sizes; dark-reddish- to dark-brown skin; mostly firm, some appeared shriveled on neck portion; flesh an off-white color which quickly oxidized; some very fibrous at the narrow portion after cooking. Three tubers each for raw and cooked samples. Sample for cooking covered with boiling water and cooked unpared for 35 to 65 minutes depending on the size. B vitamins and ascorbic acid determined. Waste (skins), 16 percent raw and 10 percent cooked.

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HAWAII AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF HAWAII
COLLEGE OF AGRICULTURE
HONOLULU, HAWAII

PAUL S. BACHMAN
President of the University

H. A. WADSWORTH
Dean of the College

MORTON M. ROSENBERG
Director of the Experiment Station