AN ABSTRACT OF THE THESIS OF

Maude Llewellyn Ashe for the M.S. in Home Economics

(Name) (Degree) (Major)

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Title Home Dehydration and Use of Green Beans, Swiss Chard, Zucchini Squash and Bell Peppers

Abstract Approved

(Major Professor)

The purpose of this study was to determine the suitability of green beans, Swiss chard, zucchini squash, and green bell peppers for home dehydration.

The vegetables were gathered in the late afternoon, refrigerated over night, and dehydrated the following day. After trimming and washing, a sample was taken for ascorbic acid determination. The remainder was weighed, blanched, and dehydrated in a pre-heated electric home dehydrator. Blanching was with either boiling water or steam to inactivate enzymes. Length of the blanch was determined by tests with 3% hydrogen peroxide and 1% benzidine in 95% alcohol to find the inactivation point of peroxidase as the test enzyme. When the vegetables had dried until they felt brittle in the fingers, they were removed from the dehydrator, weighed, and placed in screw-top glass jars. They were stored five months in a cool, semi-dark room before further work was done. Five gram samples were then rehydrated to determine proper method of rehydration and percentage of rehydration. Larger portions were cooked alone and in combination with other foods. These products were scored on a 5-point scale by a panel of three foods and nutrition instructors for form, color, odor, texture, flavor, and general acceptability. Ascorbic acid assays were made on the dry material.

The flavor and consistency of all these vegetables was changed by dehydration and subsequent rehydration. Swiss chard, sliced beans, and bell peppers resulted in acceptable products, and snapped beans in a fairly acceptable product. Zucchini squash and chard stems were not acceptable. In no case was rehydration complete. Percentages were: green beans, snapped, 36.7%; green beans, sliced, 42.9%; Swiss chard leaves, 83.8%; Swiss chard stems, 54.4%; zucchini squash 41.2%; and bell peppers, 27%.

None of these home dehydrated vegetables would furnish an effective source of vitamin C. The beans retained only 5% and the Swiss chard 12% of their original content. Bell peppers, after dehydration and storage, supplied only 6.4 mg. per 100 gms. calculated on the fresh basis.
HOME DEHYDRATION AND USE OF GREEN BEANS, SWISS CHARD, ZUCCHINI SQUASH AND BELL PEPPERS

by

MAUDE LLEWELLYN ASHE

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APPROVED:

Professor of Foods and Nutrition
In Charge of Major

Head of Department of Foods and Nutrition

Chairman of School Graduate Committee

Chairman of State College Graduate Council
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HOME DEHYDRATION AND USE OF
GREEN BEANS, SWISS CHARD, ZUCCHINI SQUASH
AND BELL PEPPERS

INTRODUCTION

The purpose of this study was to determine whether or not green beans, Swiss chard, zucchini squash, and green bell peppers might be recommended for home dehydration, with a view to home storage for several months, and ultimate use as food during the winter season. These vegetables were chosen because they are generally plentiful in home gardens during the late summer, and they have not been extensively studied for dehydration suitability.

Prescott's (25) standards for dehydrated vegetables, which are acceptable as a measure of quality, may be summarized as follows:

Good dehydrated vegetables should preserve the characteristic odor and flavor of the fresh food, with minimal losses of mineral salts and only slight color changes. Digestibility should be unchanged, vitamin values not entirely lost, and the keeping quality for at least a year should be assured. To achieve this, raw food must be of good quality and methods of dehydration and storage carefully controlled.

While dehydrated foods are not the same product as either fresh or canned foods, they should be desirable in themselves.

If, for some reason, fresh vegetables or vegetables processed by other methods are not available, dehydrated vegetables may be important. They are psychologically
satisfying when incorporated in meals otherwise lacking in vegetables, and they retain some of their original nutritive value.

In the dehydration of vegetables certain physical principles are involved: the constancy of heat and energy and the latent heat of vaporization may be mentioned. The weight of the fresh vegetable equals the combined weights of the dried vegetable, the evaporated water and certain minor losses. The heat input equals the outgo of heat used in heating the dryer and trays, radiation from the walls of the dryer, heat of the spent air and latent heat of vaporization. This latter expenditure may be very high, since several times as much heat is required to vaporize a given weight of water as is needed to heat it from 60°F. to the boiling point 212°F. (6)

Early in the drying process, when moisture is visible on the surface of the vegetables, the rate of evaporation is controlled by three factors: 1) the vapor tension of the water corresponding to its temperature, 2) the vapor tension of the moisture in the air corresponding to its absolute moisture content, 3) the effective velocity of air over the surface of the material. Temperatures may be fairly high during this period. (29) Mrak recommends a temperature as high as 180°F. to begin dehydration and hasten the entire process. (24)

The next stage is the "falling rate period", which is
characterized by a dry surface with moisture being absorbed from the interior. Drying ceases when the vapor pressure of the air and that of the material are equal. Drying should not go below the saturation point of the food being dried. The saturation point may be described as the point beyond which water, chemically combined in the tissues of the vegetables, may be withdrawn, resulting in chemical changes of the material. As vegetables near the end of the drying period, they become susceptible to heat damage. There may be irreversible changes in structure if the higher temperatures permissible during the early period are continued too long. (29) The drying rate of each vegetable is characteristic. (6)

Humidity should be high during the initial period to prevent hardening and drying of the outer surfaces, but the humid air must be removed at a rate which will not retard drying. Slade recommends seventy-five percent saturation for air leaving the dryer. (29) Heating by convection currents insures more uniform drying and removal of liberated moisture. The heated air gives up part of its heat to vaporize the liquid and removes it as the air currents pass over the drying vegetables. The drying rate increases with the velocity of the air currents. (6)

A vitally important consideration is the control of enzymes, their prosthetic groups and complexes. Enzymes, whether produced by microorganisms or present as chemical
constituents of the foods themselves, are responsible for food spoilage. Inactivation of enzymes is a recognized and necessary part of all food preservation processes. In dehydration of vegetables, two methods of enzyme inactivation are combined. Heat is used in blanching of the vegetables before drying, and water content is reduced in the drying itself. This reduction in water severely limits the activity of enzymes, for their activities need water. (3)

The water in plant tissues is of two kinds: hygroscopic and capillary. The capillary or free water is present between the fibers, in the capillary spaces. Removal of this water will not alter the material in any way except to decrease its weight. The hygroscopic water, however, is chemically combined with the material, and its removal results in chemical as well as physical changes in the material. When the chemically combined or hygroscopic water is reduced below the saturation point, physical changes such as shrinkage and hardening of fibers occur. To prevent physical change of vegetable material upon the one hand and decomposition by enzyme action upon the other, it is necessary to adjust the moisture content at a place above the saturation point for hygroscopic water (29) and below the region of capillary condensation. This narrow range was found to be in the neighborhood of 5% moisture content for most vegetables. (22) So slight are the needs for partial
enzyme action, that Ball feels even the water of hydration may supply enough moisture for some enzyme activity during storage. (2)

The enzymes concerned in vegetable deterioration and inactivated by blanching are made up of a prosthetic group and a characteristic protein. The prosthetic group may act by itself, but its activity is much greater when it is joined to its protein base. Heat appears to have two somewhat separate effects on these enzymes. Its first effect is to separate the prosthetic group from the enzyme protein. The second effect is to denature or partially denature the protein. Balls' experiments with turnip and cabbage juices would indicate that these effects may not be permanent. Reversion to active enzyme after almost complete denaturation amounted to 30% in twenty hours, when the heated juice was allowed to cool. However even a partial and temporary destruction is important, for it inhibits enzyme action during the dehydration period, and limits it during storage. (3,2)

Traces of activity may be due to the presence of unchanged prosthetic groups, more resistant to heat than the protein of the enzyme. Balls suggests that blanching may break the metabolic chain by destroying some member or members of a series of enzymes. If this theory be true, we would have the failure of one enzyme to carry on its part of a long process to a point where another enzyme could carry on a further step toward completion. This could re-
result in the piling up of waste products of plant metabolism just before the point at which the chain was broken and might account for development of off odors and flavors. (3)

Iron, copper, and their compounds have some oxidizing power for ascorbic acid. The prosthetic groups of the enzymes concerned in vegetable deterioration are compounds of these metals. The metals themselves, the prosthetic groups, the enzymes, and enzyme complexes will catalyze the oxidation of ascorbic acid to dehydroascorbic acid. This may be reduced again to ascorbic acid by hydrogen sulfide and some other reductants. Both of these forms are biologically active. Should the oxidation be carried further, a compound is formed which may not be reduced and is inactive as an anti-scorbutic agent. (18)

Kertesz and co-workers felt that the continued reactivity of some oxidizing substance in vegetable juices after thermal destruction of the enzyme might be due to the copper or iron content of the vegetable. (18)

Of the several enzymes which cause deterioration of vegetables after hydration and during storage, peroxidase is generally used as the test enzyme. It has been chosen because it is not as easily inactivated by heat as most enzymes; it reverts on cooling unless heating has been thorough, and the tests used are simple. (3) However Balls and Kent feel that it might be better to standardize tests
for enzymes which actually cause deterioration of the food, such as ascorbic acid oxidase. (2) Stevens too feels the need of suitable scientific tests for the enzymes which cause losses of food nutrients, and points out that the reagents used in testing for active peroxidase give various reactions with the same vegetable. For instance, in tests on the same lot of white potatoes, guaiacol gave a negative reaction after a three minute blanch, \( \alpha \)-naphthol required seven minutes, and benzidine nine minutes. (30) Dixon (11) considers guaiacol superior to benzidine, catechol, or p-phenylene diamine.

Of the many possible peroxidase testing reagents, Cruess and Joslyn (8) chose six (catechol, pyrogallol, \( \alpha \)-naphthol, gum guaiacum, guaiacol and benzidine) for comparative tests. They prepared the reagents as 1% tinctures in 95% alcohol, using several drops with three to four drops of 3% hydrogen peroxide. Their conclusions were that no one reagent was most desirable for use with all vegetables, and furthermore that inactivating temperatures for peroxidase vary with different vegetables, and with different lots of the same vegetable. Davis (9) also notes this latter point. In another paper, Cruess points out that the benzidine test is not specific. Traces of iron and copper in the vegetable may give coloration after the peroxidase has been destroyed. (5) An effort to make this persistent test negative would lead to over-
blanching.

Storage conditions which exclude insects and prevent spoilage by bacteria, may not prevent loss of ascorbic acid. Cruess and Tsu (7) found that dehydrated vegetables stored in air at 30°C. for "several months" were practically devoid of ascorbic acid. Hollingshead (16) states that vitamin losses in storage may be equal to, or even larger than, those incident to the preparation and dehydration of the product. Aykroyd (1) recommends that oxygen be exhausted from package containers of dehydrated foods, and observed that there seemed to be better ascorbic acid retention in those vegetables which remained crisp. This would seem to indicate that absorbed moisture was at least partially responsible for deterioration in his studies. Mrak (24) states that the presence of air and moisture hasten chemical changes in dehydrated food, resulting in discoloration, loss of vitamins, off odors and flavors. Storage of laboratory samples in vacuo, in nitrogen, or in carbon dioxide has preserved their ascorbic acid content, by effectively preventing the entrance of oxygen. (7) Rising temperature hastens deterioration. Spinach stored four months kept well at 32°C and 65°F., but developed a "hay" odor at 82°F. (31) It has also been found that length of storage affects the rate of rehydration. (10)

The procedure for rehydration has not been standard-
ized. Time and temperature of this process should be suitable to the material used, and varies with the food, variety, and method of preparation used for dehydration. Davis and Howard point out in addition, that while rehydration and cooking will both occur at a boiling temperature, the two will not proceed at the same rate. (10) Directions vary widely, ranging from "soaking one half hour to several hours", (33) to "adding to boiling water" (23). Moyer (23) states that the vegetables not soaked at all were the most palatable, and rated those soaked the longest time as soggy. But California workers (31) felt that several non-leafy vegetables (carrots, broccoli, corn, squash, green beans) improved when soaked longer or shorter periods.

There is better agreement on the rate of cooking. A slow rate of boiling is preferred to rapid or vigorous boiling regardless of the amount of soaking (33, 14, 31, 10).

The rehydration ratio is seldom equal to the dehydration ratio, and may be as low as fifty percent for the most satisfactory form of a rehydrated vegetable. (24)

The rate of rehydration is directly proportional to the surface volume and surface weight ratios of the individual pieces of vegetable. The fact that optimal quality may be found with rehydration of less than 100% may be due to some chemical change in the solids during the processes of blanching and drying. (10)

Retention of vitamin C in processed vegetables is ac-
cepted as a reliable criterion of quality for the product. This is the most easily destroyed of the nutrients and the most easily dissolved of the vitamin or mineral substances. If it is retained, so will aroma, color, flavor, texture and other nutrients be retained. Even though it be in part destroyed, the methods which minimize its loss will in the same measure save other nutrients. Drying is very destructive of ascorbic acid. The problem has been to find methods of drying which will destroy less of the vitamin. (13)

The vegetables should be handled as quickly as possible, although there is less loss from enzyme-activated oxidation before blanching if the tissues are not bruised. (27) Blanching shows a high initial destruction of vitamin C, but the ultimate loss of this vitamin and of other desirable factors will be greater if blanching is omitted. Overblanching results in progressive loss of water soluble substances. (23) Steam blanching is less destructive than blanching in boiling water, as there is less loss by solubility. (16,7) Using the same blanching water repeatedly does not decrease solubility losses. The blanch should raise the temperature of the vegetables to 190°F. in about one and a half minutes. (16)

Several papers have expressed the desirability of a fairly high temperature (Mrak 185°F.) for the first period of drying, as this is a period favorable to the activity of
any surviving oxidizing substances. Rapid reduction of
moisture will limit this possibility. (24,7,33) The pH
of the vegetables is important, for ascorbic acid oxidase
is more active in non-acid than in acid vegetables. (13)
Storage conditions favorable to ascorbic acid retention
are discussed elsewhere.

The palatability scores of dehydrated vegetables are
based on appearance, odor, flavor, consistency, and accep-
tability, or a combination of similar qualities. They are
a means of evaluating the dehydration process, storage con-
ditions, and dietary values of the rehydrated and cooked
product. (4) Dehydrated vegetables were supplied to Ameri-
can soldiers during both the Civil War and World War I.
Because of poor methods of dehydration and storage, they
were unattractive and not well eaten. (24)

Mrak points out that dehydrated vegetables cannot be
considered the equal of either fresh or canned vegetables.
We are dealing with a product which differs in flavor, tex-
ture, appearance, aroma. (24) Another California study
found scores on the palatability of good quality dehydra-
ted vegetables to be higher than those for canned vegeta-
bles. (31)

The characteristic odor and flavor of the vegetables
should be preserved and color changes should be reduced
to a minimum. (25) Changes do occur for one reason or
another. They may be due to enzyme action as mentioned
elsewhere. Hollingshead considers some unpleasant odors and flavors may be due to rancidity, possibly because of a proportional increase in fat with the decrease of water content. (16) Moyer says that presoaking of vegetables decreases general palatability, giving them a soggy texture. (23) In the study of Stillman, Watts and Morgan previously mentioned, rehydrated green beans were marked down because of their shrunken appearance. (31)

The ascorbic acid content of green beans is generally considered to be rather low. Mack and others in 1938 conducted an extensive investigation. Their conclusions were that there is considerable variation with variety, among pods grown on the same vine, in different parts of the same pod, between pods and seeds, and with degree of maturity. In general the seeds are considered to be a richer source of ascorbic acid than the pods. (21) In very young beans, the pods are richer, but the ascorbic acid content declines to a constant level and the developing seeds increase in potency. Pods which are less mature or more mature than the stage at which they are generally picked are a better source of ascorbic acid than at the usual stage of picking. Freshness is important, as oxidation is very rapid unless retarded by a low storage temperature. (21, 13) Dehydration processes result in almost total loss of ascorbic acid. (30)

Batchelder reported smaller loss of ascorbic acid
when the beans were shredded or cut than when they were left whole—due to a more rapid and complete thermal destruction of enzymes. (4) Stillman, Watts, and Morgan had successful rehydration of beans only when they had been shredded lengthwise. (31)

The leaf or blade of fresh chard is considered a good source of ascorbic acid. The midrib is less valuable, and the stem a relatively poor source. (28,15) The vitamin is easily destroyed, as the ascorbic acid oxidase is very active in chard. However the enzyme is largely inactivated in the first two minutes of cooking. (15) Any slow cooking method is destructive of the vitamin, and dehydration is particularly so. (13) There is little published material concerning dehydrated chard. Batchelder feels that the vegetable needs more study. (4)

Reports from California (31) and Georgia (33) agree that summer squashes should be dehydrated while immature and tender. The California study (Stillman, Watts, Morgan) states specifically that if the seeds have developed, moisture is held around them and a somewhat bitter flavor develops. They did not retain either color or flavor well, even though blanched, and could not be considered more than moderately successful for dehydration. (31) Zucchini has not been extensively studied for ascorbic acid content, but it ranks low according to existing figures. Burrell and Ebright (4A) reported a market sample
of unknown variety as yielding .237 mg. of ascorbic acid per gram of fresh weight. A garden fresh sample might have ranked higher, as their market samples were generally lower in vitamin C than the corresponding fresh samples.

It would appear that peppers are a rich source of ascorbic acid. Lantz (20) in a recent study (1943) of several varieties found a very high vitamin C content regardless of the stage of ripeness, although ascorbic acid content increased as the peppers ripened. An individual assay yielded 561 mg. per 100 g. of ripe pepper, and an average of three assays on the same variety was 408 mg. per 100 g. of material. The author does not include figures on the stability of vitamin C to dehydration procedures.
Method of dehydration

The vegetables were dehydrated in a home electric food dehydrator designed and constructed by the Agricultural Experiment Station. (26) Heat was provided by a bank of 150-watt electric lamps totalling 1350 watts. To reduce heat, any number of these lamps might be individually removed. Air circulation was provided by an office type electric fan built into the dehydrator and operated on the same current which furnished heat. A temperature range of 145°-150°F. was maintained by adjusting the electric lamps and sliding air control panels in the doors of the dehydrator. Approximately one hour of pre-heating was needed to prepare the dehydrator for drying vegetables. Some of this heat was absorbed by the structure, and some heat leakage through the walls was evident during operation. The vegetables were spread on wood slatted trays, constructed to leave 1/8 inch space between slats. To facilitate circulation of air, tray supports on the sides of the cabinet were so arranged as to space the trays three inches apart on centers. Tray stops on the tray supports placed the trays in such a way as to leave one and a half inches between the top tray and the rear wall of the cabinet. The top tray, when so arranged, was ten and one half inches from the door in front. Each tray was farther for-
ward than the one above it. The bottom tray was six inches from the front and six inches from the back.

The beans, chard and peppers were grown on the college farm and the squash was supplied from a private garden in the area. In all cases, the vegetables were picked in the late afternoon and refrigerated overnight. The following morning, a representative sample of each lot of vegetables was removed for ascorbic acid determination. The remainder was prepared for dehydration.

The vegetables were washed, drained, and trimmed before weighing to the nearest 10 grams. The fresh weight, as recorded, includes what moisture might cling to the vegetables after trimming. This weight excludes the unused portion of vegetable and the soil adhering to them as they were brought from the field.

Both steam and boiling water were used for blanching. For the water blanch, the prepared vegetables were dropped into rapidly boiling water, and boiled until the test for enzymes was negative on a freshly cut surface. They were removed from the water and spread on the drying trays. For the steam blanch, the vegetables were spread on the drying trays and placed in a closed vat steamer large enough to hold several dehydrator trays. The use of this steamer was a matter of convenience, and would not be necessary for effective steam blanching. When vegetables which had been tested for enzyme activity after a water blanch were
steamed, approximately twice the blanching time found effective in boiling water was allowed in the steamer. For those vegetables not tested, blanching time had been established by previous tests.

Enzyme destruction was determined by testing for peroxidase. The method used was to add two to three drops of 3% hydrogen peroxide and two drops of 1% benzidine in alcohol to a freshly cut surface of the vegetable material. Presence of active peroxidase is indicated by the development of a dark blue color. The most persistently positive reactions were found in the strings of beans and fibrous pulp material about the seeds of zucchini.

The conditions of work throughout were such as could be duplicated in the home kitchen. The large vat used for steam blanching was a convenience and saved time, but effective steaming can be accomplished in the home with smaller equipment.

Two varieties of green beans, Pioneer and Blue Lake, were dehydrated. They received the same treatment throughout, with necessary adjustment for blanching and drying time. After tipping and stringing, they were snapped in approximately two inch lengths. A small portion of immature Pioneer beans were sliced lengthwise. The fresh weight of these sliced beans was not differentiated from the total weight of Pioneer beans prepared that day. They were, however, kept separated in blanching, drying, and
storage container. All the Pioneer beans were water blanched for five minutes, spread on trays, and placed in the pre-heated dehydrator. A portion of the Blue Lake beans was water blanched nine minutes and spread on dehydrator trays. The remainder was steam blanched fifteen minutes after being spread on the trays. Both water and steam blanched beans were placed in the pre-heated dehydrator together. Both varieties of bean were tested for peroxidase activity with 3% hydrogen peroxide, and 1% benzidine in alcohol. The strings gave the most persistent reaction.

The Pioneer beans, which had been sliced lengthwise, were dry at the end of seven hours, while the Pioneer beans snapped in two inch pieces were not dried until the end of eight and one half hours. The Blue Lake beans needed eleven hours for drying. However, they dried somewhat unevenly, as a part of them were dry at the end of six hours, while other pods on the same tray were still noticeably damp. Since they were on the same tray, this could not have been due to difference in the blanching process. The beans were considered dry when they felt brittle and broke easily between the fingers.

After drying, the beans were weighed, and placed in screw top, 1- quart glass jars for storage. The drying ratio for Pioneer beans was 11.7:1 and for Blue Lake beans, 10.7:11.
Steam blanching seemed most desirable for the chard, because of its great surface area and the consequent probable loss of soluble substances. After the midrib and stem were removed, the uncut leaves were spread on the dehydrator trays, steam blanched three minutes and placed in the preheated dehydrator. The chard was not tested for enzyme activity at this time. The midribs and stems were sliced in one inch pieces and dried separately.

At the end of five hours, the chard and stems were dried. They were weighed on the same scale, and placed in screw top 1-quart glass jars for storage. The dehydration ratio was 11.4:1.

The zucchini squash supplied from a private garden, were larger than those usually found in the market, but only one of them seemed over mature. Since the seeds in this one squash were large and firm, they were removed along with the tissues in which they were embedded. The other squash seemed entirely edible, and no portion of them was discarded. All were split lengthwise, and sliced crosswise in three-eighths to one-half inch slices. Those which were water blanched gave a persistently positive peroxidase test with 3% H₂O₂ and 1% benzidine in alcohol on a freshly cut surface until they had been boiled eight minutes. After blanching, the slices were spread on dehydrator trays. The remainder was spread on dehydrator trays, and steam blanched fifteen minutes. The blanched zucchini was then placed in
the heated dehydrator.

At the end of twelve and one-half hours, the zucchini slices were completely dried. They stuck to the unoiled trays, and had developed an unpleasant odor. However, they were weighed on the same scale and placed in screw top 1-quart glass jars for storage. The drying ratio for the zucchini was 11.2:1.

The peppers were prepared by removing the stems, seeds, and white inner membranes. They were then sliced lengthwise into strips approximately three-eighths of an inch in width. They were spread on dehydrator trays, which had been oiled with mineral oil, and steam blanched ten minutes before being placed in the pre-heated dehydrator. They were not tested for enzyme activity. At the end of nine hours, the peppers were completely dried. The practice of oiling the trays was of assistance in removing the dried strips after dehydration. They were weighed on the same scale, and placed in screw top one-quart glass jars for storage. The drying ratio for bell peppers was 15.9:1.

**Storage**

After the dried weights were determined, the dehydrated vegetables were placed in screw top, 1-quart glass jars. The jars were labeled with the name of the product, variety if known, weight, type of blanching, drying time, and date. The jars were then placed on a shelf against an
TABLE I
Dehydration of Vegetables

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<th>Vegetables</th>
<th>Variety or Part</th>
<th>Blanch (type)</th>
<th>Blanch (time)</th>
<th>Drying Time (hrs)</th>
<th>Raw Weight (gms)</th>
<th>Dry Weight (gms)</th>
<th>Drying Ratio</th>
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<td>Pioneer</td>
<td>Water</td>
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<td>11.7:1</td>
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<td></td>
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<td></td>
<td>5</td>
<td>7</td>
<td></td>
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<td>&quot;</td>
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<td>11</td>
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<td>2000</td>
<td>175</td>
<td></td>
<td></td>
<td>11.4:1</td>
</tr>
<tr>
<td>Zucchini</td>
<td>Water</td>
<td>8</td>
<td>12.5</td>
<td>4300</td>
<td>375</td>
<td>11.4:1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Steam</td>
<td>15</td>
<td></td>
<td>2000</td>
<td>175</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bell peppers</td>
<td></td>
<td>Steam</td>
<td>10</td>
<td>9</td>
<td>3925</td>
<td>240</td>
<td>16.3:1</td>
</tr>
</tbody>
</table>

* This ratio was used in computing rehydration coefficients for Swiss chard.
inner wall of a cool storeroom in semi-darkness. The vegetables were protected from sunlight, and the room was unheated. They remained undisturbed for approximately five months before rehydration was attempted.

Method of rehydration

Five gram samples of the dehydrated vegetables, weighed on a trip balance, were used in determining suitable methods of rehydration. These samples were placed in 250 ml. beakers and covered with a measured amount of tap water. A suitable amount of water was determined separately for each vegetable, and measured from a standard graduate. "Cold" water was as it came from the tap, and had a temperature range of 20°-23°C. "Hot" water is understood to mean water which had been measured while cold, and brought to the boiling point (98°-100°C). Heat for cooking was supplied by an open coil electric unit. This was turned to highest heat to bring vegetable material quickly to the boiling point. To maintain a moderate temperature for gentle boiling, the unit was turned to medium heat and the beakers arranged in such a way that two wire coils passed under each beaker.

The vegetables were cooked for varying lengths of time, and drained at once through an agate-ware colander. Drainage was for one minute, twenty seconds with the colander upright, twenty seconds tipped to the left, and twenty seconds tipped to the right. The drained material was
then weighed on the same trip balance and the remaining cooking liquid measured in the same graduate. The volume of cooking water was of only comparative interest, for an undetermined amount was lost by evaporation. Rehydration ratios and coefficients were based upon weight of solid material before and after cooking.

**Method of rehydration (2)**

Variations were tried in regard to amount of water used for soaking and cooking, temperature of the water, time allowed for pre-soaking, length of cooking time, and rate of cooking. In all cases the soaking water was used in cooking the vegetable. In no case was there complete rehydration. Some of these vegetables absorbed more water with a longer soaking period, but longer soaking did not improve their texture, flavor, nor appearance.

**Ascorbic acid**

Ascorbic acid determination was made by a modification of the method of Loeffler and Ponting (Ind. and Eng. Chem. Anal. Ed. 14:841-849, 1942), using the Evelyn photoelectric colorimeter. (32)
RESULTS AND DISCUSSION

If division were made according to both variety and method of preparation, there were four lots of dehydrated green beans to consider. The Pioneer beans were all water blanched, but a few of them were sliced lengthwise. The remainder were snapped. All of the Blue Lake beans were snapped, but a portion were water blanched, and a portion steam blanched.

Five gram samples of the snapped Pioneer beans were covered with fifty ml. of water and pre-soaked four, two, one and no hours in 250 ml. beakers. They were then brought quickly to the boiling point, and gently boiled for eight minutes. At the end of this period, they were drained at once for one minute through an agate-ware colander, and then weighed on the same scale (See Table II). There was no greater absorption of water with the longer soaking period, but some soaking seemed desirable. All samples were tough, flat and shrivelled in appearance. They had a fair flavor, but it was one characteristic of beans cooked for a long period. One five gram sample was dropped into 75 ml. of boiling water, cooled to room temperature, and stored, covered, in the refrigerator for seventeen and one half hours. It was cooked, drained, and weighed as the other samples were. It showed increased water absorption by weight, was more tender, but still
TABLE II
Rehydration of Dehydrated Vegetables
5 gram samples used

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Dehydration Ratio</th>
<th>Soaking Time (hrs.)</th>
<th>Cooking Time (mins.)</th>
<th>Weight of Rehydrated Vegetables (gms.)</th>
<th>Ratio of Rehydrated Vegetables to dry Vegetables</th>
<th>Coefficient of Rehydration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green Beans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pioneer (snapped)</td>
<td>11.7:1</td>
<td>4</td>
<td>8</td>
<td>21.2</td>
<td>4.24</td>
<td>36.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>8</td>
<td>21.8</td>
<td>4.3</td>
<td>37.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>8</td>
<td>21.5</td>
<td>4.3</td>
<td>36.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>8</td>
<td>19.3</td>
<td>3.8</td>
<td>33.0</td>
</tr>
<tr>
<td></td>
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<td>8</td>
<td>26.7</td>
<td>5.3</td>
<td>45.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>16</td>
<td>20.5</td>
<td>4.1</td>
<td>35.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>20</td>
<td>20.2</td>
<td>4.04</td>
<td>34.5</td>
</tr>
<tr>
<td></td>
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<td>1</td>
<td>24</td>
<td>20.0</td>
<td>4.0</td>
<td>34.2</td>
</tr>
<tr>
<td>Pioneer (sliced)</td>
<td>11.7:1</td>
<td>1</td>
<td>8</td>
<td>25.1</td>
<td>5.0</td>
<td>42.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>8</td>
<td>23.6</td>
<td>4.7</td>
<td>40.3</td>
</tr>
<tr>
<td>Blue Lake (water blanch)</td>
<td>10.7:1</td>
<td>4</td>
<td>8</td>
<td>19.0</td>
<td>3.8</td>
<td>35.5</td>
</tr>
<tr>
<td>(steam blanch)</td>
<td>10.7:1</td>
<td>1</td>
<td>8</td>
<td>17.7</td>
<td>3.5</td>
<td>33.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>8</td>
<td>17.0</td>
<td>3.4</td>
<td>31.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>8</td>
<td>20.0</td>
<td>4.0</td>
<td>37.3</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>8</td>
<td>18.3</td>
<td>3.6</td>
<td>34.2</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>8</td>
<td>16.7</td>
<td>3.3</td>
<td>31.3</td>
</tr>
<tr>
<td>Zucchini squash</td>
<td>11.5:1</td>
<td>4 (cold) 8</td>
<td></td>
<td>21.5</td>
<td>4.3</td>
<td>37.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 &quot;</td>
<td>8</td>
<td>21.0</td>
<td>4.2</td>
<td>36.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 &quot;</td>
<td>8</td>
<td>18.5</td>
<td>3.7</td>
<td>32.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 (hot) 8</td>
<td></td>
<td>23.5</td>
<td>4.7</td>
<td>41.2</td>
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<tr>
<td></td>
<td></td>
<td>2 &quot;</td>
<td>8</td>
<td>24.5</td>
<td>4.9</td>
<td>42.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 &quot;</td>
<td>8</td>
<td>23.5</td>
<td>4.7</td>
<td>41.2</td>
</tr>
<tr>
<td>(Additional soaking after cooking)</td>
<td>19</td>
<td></td>
<td></td>
<td>33.5</td>
<td>7.7</td>
<td>67.5</td>
</tr>
<tr>
<td>Vegetable</td>
<td>Dehydration Ratio</td>
<td>Soaking Time (hrs.)</td>
<td>Soaking Time (mins.)</td>
<td>Cook- ling Time</td>
<td>Weight of Rehydrated Vegetables (gms.)</td>
<td>Ratio of Rehydrated Vegetables to dry</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>----------------</td>
<td>----------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Swiss Chard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stems</td>
<td>11.2:1</td>
<td>4</td>
<td>7</td>
<td></td>
<td>29.5</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(Started in cold water)</td>
<td>9.9:1</td>
<td>0</td>
<td>-</td>
<td></td>
<td>37.5</td>
<td>7.5</td>
</tr>
<tr>
<td>(Steeped only)</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td>38.5</td>
<td>7.7</td>
</tr>
<tr>
<td>(Boiled)</td>
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<td></td>
<td></td>
<td>43.5</td>
<td>8.7</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>2</td>
<td></td>
<td></td>
<td>41.5</td>
<td>8.3</td>
</tr>
<tr>
<td>Bell Peppers</td>
<td>16.3:1</td>
<td>4 (cold)</td>
<td>5</td>
<td></td>
<td>23.2</td>
<td>4.6</td>
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<tr>
<td></td>
<td>1</td>
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<td>5</td>
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<td></td>
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<td>5</td>
<td></td>
<td>22.0</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>20.0</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td>20.3</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>7</td>
<td></td>
<td></td>
<td>22.2</td>
<td>4.4</td>
</tr>
</tbody>
</table>
wrinkled and flat in appearance, with a tendency for the skin to slough. Increased cooking time did not result in increased water absorption. Samples were pre-soaked for one hour in 50 ml. of hot water before cooking. They were then cooked gently for eight, sixteen, twenty, and twenty-four minutes. The product was still wrinkled, flat and the flavor became stronger in proportion to the length of the cooking period. None of the samples was attractive in appearance.

The Pioneer beans which were sliced lengthwise were somewhat less mature than the average of the entire Pioneer lot, although not all of the young beans were removed from the entire lot for slicing. Except for slicing, they had received the same treatment during preparation, dehydration, and storage as the other beans. Five gram samples of these sliced beans were placed in 250 ml. beakers, with 75 ml. of water. One lot was pre-soaked one hour in hot water, and the other placed in cold water and brought quickly to the boiling point. They were boiled gently for eight minutes, and then drained and weighed as were the other beans for comparison. Hydration and texture were slightly better for those pre-soaked, and color and general appearance of both lots were similar. Both were a fresher green than the snapped beans, and gave the appearance of being plumper. The cut edges rolled toward the center, stretching the skin so that they did not seem so wrinkled. The impression was
that these were very slender beans. The flavor was more
delicate than that of the snapped beans.

Part of the Blue Lake beans were water blanched, and
the remainder were steam blanched. The dried beans, after
storage, differed in color, the water blanched lot being
greener than the others. After they were cooked, this
difference was greatly lessened. It was then difficult to
distinguish the two lots. Five gram samples of each lot
were pre-soaked four, one, and no hours. They were then
brought quickly to the boil, boiled gently, and drained and
weighed as were the other beans. In texture, flavor, color,
and general appearance they were very similar to the snapped
green beans. In no case was there satisfactory rehydration.

The leaves of Swiss chard needed no pre-soaking. Five
gram samples were placed in 250 ml. beakers with 150 ml.
of water (Table II). This volume of water was desirable
for two reasons. The leafy nature of the vegetable made it
difficult to cover the entire portion without breaking it
badly, unless a rather large volume of water was used.
The cooking water was strong flavored, and discarding a
large volume of this strong flavored cooking water produced
a better flavored vegetable. Very little cooking time was
necessary, as the leaves, which had been partially pre-
cooked in the steam blanch, absorbed water readily and
seemed overcooked very soon. One or two minutes at the
boiling point was sufficient. Comparable samples were
placed in hot (98°C.) water and in cold (23°C.). The one started in hot water was placed on the electric unit for two minutes. The one started in cold water was brought quickly to the boiling point and removed at once. Upon comparison, it was found that the sample started in hot water had a better color retention, but the leaves seemed more broken up. The sample started in cold water, had better retention of leaf form, but was more faded and bronzed in color. Both of these samples, as well as all others, had lost much of their characteristic texture, were overcooked to the point of mushiness. If the leaves were not drained at once, there was increased loss of texture, as well as increased hydration, amounting to sogginess.

An attempt was made to utilize the chard stems and midribs. Five gram samples were placed in 250 ml. beakers with 100 ml. of water. Samples were pre-soaked one and four hours to compare with a sample not soaked at all. At the end of the soaking period, they were brought quickly to the boil, and gently boiled seven minutes. The longer soaking period gave no better absorption of water by weight, but the texture of the product seemed more soggy. Increasing the cooking time to fourteen and seventeen minutes was not successful, as the stems were increasingly bitter with a longer cooking period. No type of treatment was found which yielded a desirable product.

Preliminary tests indicated that the seed-bearing cen-
ter portions of the zucchini slices were more bitter than the portion next to the skin. For all succeeding tests, only this firm outer portion of rind and flesh was used. Five gram samples were placed in 250 ml. beakers, covered with 75 ml. of water and pre-soaked 0, 1, 2, and 4 hours (Table II). They were then brought quickly to the boiling point, and boiled eight minutes in the same water in which they had been soaked. None rehydrated in a satisfactory manner. The zucchini was tasteless after removal from the strong flavored cooking water. The samples soaked two and four hours were increasingly soggy. Soaking in hot water resulted in slightly better water absorption, but the flavor and appearance were still unsatisfactory. The skin rehydrated better than the rest of the slice. Although somewhat shrivelled, it regained approximately its original size. The inner tissues absorbed water scarcely at all, and the contrast between the two was marked.

To find if this vegetable would absorb more of the cooking water upon standing, two samples which had been presoaked, one in hot and the other in cold water, for one hour and then cooked eight minutes, drained, and weighed, were returned to the cooking water plus an additional 100 ml. of water. These samples stood an additional nineteen hours. There was some additional water absorption, but the appearance was little changed.
Boiling five, eight, eleven, and fourteen minutes after presoaking one hour gave no improvement. The form was not improved, and the flavor was increasingly strong when the cooking water was retained. To see if better hydration could be secured with a more finely divided product, a portion of the zucchini was ground with the medium knife in a household food chopper. Five gram samples of this material were placed in 250 ml. beakers with 50 ml. of water. Both hot and cold water were tried. These were cooked eight minutes without any preliminary soaking. Apparently much of this water was absorbed, resulting in a mixture of mushy consistency which did not settle out. It looked like mashed squash. It was not weighed because drainage was not possible for this type of mixture with the equipment at hand. The odor and flavor were very unpleasant, making it unattractive as food. No further efforts were made to reconstitute and use the zucchini.

Five gram samples of the bell peppers were placed in 250 ml. beakers with 75 ml. of water (Table II). One sam-

<table>
<thead>
<tr>
<th>Sample and presoak</th>
<th>Weight</th>
<th>Dry</th>
<th>Cooked</th>
<th>Resoaked 19 hours after cooking</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - cold water, 1 hr.</td>
<td>5</td>
<td>18.5</td>
<td>33.7</td>
<td></td>
</tr>
<tr>
<td>B - hot water, 1 hr.</td>
<td>5</td>
<td>23.5</td>
<td>38.5</td>
<td></td>
</tr>
</tbody>
</table>
ple was pre-soaked for an hour in hot water, another in cold water, and a third was covered with cold water and brought quickly to the boiling point without preliminary soaking. The peppers were gently boiled in the soaking water for five minutes after being returned to the boiling point. They were then drained at once through an agate-ware colander for one minute, and weighed. The pre-soaked peppers had better hydration than those not pre-soaked, and the sample started in hot water absorbed slightly more water than the one started in cold water. The skins were undesirable, since they did not rehydrate, and remained as "papery" dry material clinging to the pieces of pepper pulp. These skins could be peeled off by hand, after cooking, or removed by rubbing the pepper through a sieve to form a puree. In color, flavor, and texture, the peppers resembled canned green chili. Removed from the cooking water, the pepper lost much of its characteristic flavor, but if some of this cooking water were included in the cooked dish, the flavor was retained.

Samples of the pepper were also soaked for two and four hours without improvement in the product. An attempt was made to removed the skins after presoaking in hot water, and before cooking. This was not entirely successful. At the end of thirty minutes, the skins could be removed with fair success, and somewhat more easily after forty five minutes. No soaking period up to seventy five minutes
yielded a product as easily peeled as the cooked peppers.

Rehydration was less than 100% in all cases (Table II), even when longer periods of presoaking and cooking were used. Except in the case of Swiss chard, a short period of presoaking seemed desirable. There was increased water absorption and more uniform texture when the beans and peppers were presoaked. Unsoaked beans were not always tender to the center, and unsoaked peppers had irregular tough areas near the edge of the strip. They did not peel as easily as those cooked after a short presoaking period. One hour seemed long enough to presoak these vegetables. While an increased soaking time gave greater water absorption, there was no improvement in appearance, texture, or flavor. It seemed advisable to obtain greater absorption by starting the pre-soak in boiling water. The texture seemed less soggy when the added absorption was gained by this method, rather than by a longer soaking period. No methods used gave a satisfactory product with zucchini squash, although its rehydration coefficient was as high as that for any of the beans.

The cooking time for all of these vegetables was rather short, but they were at least partially pre-cooked in the blanching. Longer boiling, even when the rate of boiling was gentle, developed strong flavors. In no case did vigorous boiling produce a superior product, but it was desirable to bring the vegetables quickly to the boiling
point. The chard was satisfactorily cooked, when it had been heated enough to insure boiling temperature throughout the entire mass. In the quantities used for rehydration, two minutes was sufficient when the dry leaves had been added to boiling water.

The ascorbic acid retention of these dehydrated vegetables was very poor (Table IV). Determinations were made on both fresh and dehydrated green beans and Swiss chard. The four samples of beans averaged less than 5% retention of the vitamin, with no figure higher than 5.8%. When fresh, the beans were only a fair source of ascorbic acid (15.8 and 19.4 mg. per 100 gms.), not valuable for their vitamin C content unless they were eaten in considerable quantities. After dehydration and storage under home conditions, their value as a source of ascorbic acid was negligible. The same was found true of Swiss chard. The total ascorbic acid available at any time was low. The chard assayed 11.3 mg. per 100 gms. when fresh, and retained only 12% of this (1.35 and 1.44 mg. per 100 gms. on the fresh basis) after dehydration and storage. Neither of these vegetables, after home dehydration, could be relied upon to furnish vitamin C protection.

The bell peppers, while still very low in ascorbic acid (avg. of 6.4 mg. per 100 gms. on the fresh basis), showed a higher content than either beans or chard. Value of peppers as a source of ascorbic acid is only theoreti-
cal, as a very small amount would be eaten. The retention could not be computed as figures on the fresh vegetable were not available. No determination was made on the dehydrated zucchini.

Three instructors formed a scoring committee to consider and rate the rehydrated and cooked products. They rated these products on a five point scale for form, color, odor, texture, flavor and general acceptability. The scale ranged from excellent or equal to the fresh product at five, to not acceptable at one. Intermediate points were good, fair, and poor. In reporting scores, the ratings of individual judges have been averaged, so that the five point scale has been retained in the final results. The basis of judgment was the tastes of the general public, rather than individual preference. If the judges felt that they could not recommend a product to others as a good food, they rated it low. There was not perfect agreement among them, but in general, products which were not acceptable to one judge were rated low by the others. Some of the recipes tested were ruled out, and suggestions made for the improvement of others. All recipes accepted, received a rating of three or more, but not all were equally well liked.

The green beans were considered in two judging sessions. At the first session, the judges compared four samples of rehydrated snapped beans, presoaked for varying
### TABLE IV

Ascorbic Acid Retention of Vegetables in Drying

<table>
<thead>
<tr>
<th>Vegetables</th>
<th>Mg. per 100 grams of Fresh Material</th>
<th>Drying Ratio</th>
<th>Mg. per 100 grams of Dry Material</th>
<th>Calculated Retention on basis of Fresh Material Mg. per 100</th>
<th>Retention Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green beans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pioneer, snapped</td>
<td>19.4</td>
<td>11.7:1</td>
<td>11.8</td>
<td>1.00</td>
<td>5.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13.2</td>
<td>1.12</td>
<td>5.81</td>
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<tr>
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<td></td>
<td></td>
<td>8.45</td>
<td>.72</td>
<td>3.71</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9.92</td>
<td>.82</td>
<td>4.22</td>
</tr>
<tr>
<td>&quot; sliced</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue Lake</td>
<td>15.8</td>
<td>10.7:1</td>
<td>8.45</td>
<td>.79</td>
<td>5.00</td>
</tr>
<tr>
<td>Steam blanched</td>
<td></td>
<td></td>
<td>6.98</td>
<td>.65</td>
<td>4.11</td>
</tr>
<tr>
<td>Water blanched</td>
<td></td>
<td></td>
<td>8.83</td>
<td>.82</td>
<td>5.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8.45</td>
<td>.79</td>
<td>5.00</td>
</tr>
<tr>
<td>Swiss chard, leaves</td>
<td>11.3</td>
<td>9.9:1</td>
<td>13.4</td>
<td>1.35</td>
<td>11.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14.3</td>
<td>1.44</td>
<td>12.74</td>
</tr>
<tr>
<td>Zucchini squash</td>
<td>14.4</td>
<td>11.8:1</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Bell peppers</td>
<td>--</td>
<td>16.3:1</td>
<td>112.0</td>
<td>6.89</td>
<td>--</td>
</tr>
</tbody>
</table>
lengths of time. The judges found no advantage in the longer soaking period, except a very slight increase in tenderness. Since this was balanced by loss of color, the texture difference was not considered important. All of the samples had good flavor, and fair color and odor, but the appearance of the beans was not inviting. The pods were flat and shrivelled, and no soaking time up to seventeen hours, or cooking time up to twenty-four minutes had been able to overcome this. However, the flavor and color of the beans seemed to justify further work to overcome this difficulty in form.

At the second scoring session, the snapped beans which had been presoaked one hour and cooked eight minutes were served in three ways. They were seasoned with bacon and onion, with tomato juice and onion, and served in a fish chowder. All of these products were considered good from the standpoint of flavor. The undesirable form of the pods was less apparent in the tomato sauce and the chowder. The texture also seemed improved. The chowder was best liked of these products. After preliminary rehydration tests, it was thought the sliced beans would be acceptable without the additional treatment needed by the snapped beans. Like the snapped beans they were presoaked one hour and boiled eight minutes before seasoning. One portion was buttered, and the remainder used in a salad. The form and
color of these beans were noticeably superior to those of the snapped beans and they were better received by the judges. The flavor was equally good, and the texture was similar. The judges agreed that all of the beans, whether snapped or sliced, were rather more firm than is usual in fresh beans. They accepted this in the salad, or as a contrast to softer foods when the beans were served in a sauce or in the chowder, but did not like it so well when the beans were served alone.

### TABLE V

**Judges' Ratings of Green Beans**  
(on a 5-point scale)

<table>
<thead>
<tr>
<th>Snapped beans</th>
<th>Presoaking time (hrs.)</th>
<th>Form</th>
<th>Color</th>
<th>Odor</th>
<th>Texture</th>
<th>Flavor</th>
<th>Acceptability</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3.5</td>
<td>2.5</td>
<td>4</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>3.5</td>
<td>2.5</td>
<td>4</td>
<td></td>
<td>3.2</td>
<td></td>
<td></td>
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<tr>
<td>0</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1.5</td>
<td>4</td>
<td>3.4</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Seasoning</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacon and onion</td>
<td>3</td>
<td>3.7</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3.7</td>
<td></td>
</tr>
<tr>
<td>Tomato and onion</td>
<td>3.7</td>
<td>3.7</td>
<td>4.3</td>
<td>3.7</td>
<td>4.3</td>
<td>4</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Chowder</td>
<td>4</td>
<td>4</td>
<td>4.3</td>
<td>3.7</td>
<td>4.3</td>
<td>4</td>
<td>4.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sliced beans</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Seasoning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butter</td>
<td>4.3</td>
<td>4.3</td>
<td>4</td>
<td>3.3</td>
<td>4</td>
<td>4</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>Salad</td>
<td>4.3</td>
<td>4.3</td>
<td>4</td>
<td>4.3</td>
<td>4</td>
<td>4</td>
<td>4.1</td>
<td></td>
</tr>
</tbody>
</table>
Six samples of Swiss chard were scored by the judges. The first four were products of varied rehydration methods, and there was little to distinguish one from another. The judges found it difficult to place separate values on the four products. They agreed that all samples were as satisfactory as a similar canned vegetable, but not as good as fresh chard. However, the rehydrated chard would be acceptable if fresh greens were not available. The product was rated good on texture, fair to good on color, and fair on form. The flavor was not well liked without seasoning, although the average rating was fair. One judge mentioned objectionable bitterness. Since the flavor and odor were neither highly desirable, it was felt that the product could be improved by seasoning and combination with other flavors and odors. A portion seasoned with butter and onions was scored as a fairly good product, and a cream soup as good. The latter product was best liked of the chard preparations. In comparison with the other figures, the rating of the seasoned dishes was definitely higher in odor, flavor, and acceptability. All of these factors had been low for the rehydrated products.
TABLE VI

Judges' Ratings of Swiss Chard
(on a 5-point scale)

<table>
<thead>
<tr>
<th>Rehydration method</th>
<th>Form</th>
<th>Color</th>
<th>Odor</th>
<th>Texture</th>
<th>Flavor</th>
<th>Acceptability</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>3.7</td>
<td>3.5</td>
<td>4</td>
<td>2.3</td>
<td>2.7</td>
<td>3.1</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>3.7</td>
<td>2.5</td>
<td>4</td>
<td>2.3</td>
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<td>2.9</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>3.3</td>
<td>2.5</td>
<td>4</td>
<td>3</td>
<td>2.3</td>
<td>2.9</td>
</tr>
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<td>D</td>
<td>3</td>
<td>3.3</td>
<td>2.5</td>
<td>4</td>
<td>3</td>
<td>2.7</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Seasoning

- Buttered: 3 3.3 3.5 4 3.3 3.3 3.6
- Cream soup: 4 4 4 4 3.7 4 3.9

*Rehydration methods same as in Table II. Sample A was placed in cold water, brought quickly to a boil, and drained. Sample B was placed in hot water and steeped one minute. Sample C was placed in hot water and steeped two minutes. Sample D was placed in hot water and boiled two minutes.
Preliminary rehydration work on zucchini squash had not produced a satisfactory product. Two rehydrated samples were presented to the judges for scoring. One sample had been presoaked four hours, and the other one hour. There was little distinction between them, except that the color of one was slightly better, but not enough to over-balance other defects. Both were rated as poor and "not acceptable". This was the least successful of the vegetables studied. It was not felt that the product had sufficient nutritive value or desirability to warrant further work.

TABLE VII

Judges' (Ratings of Zucchini Squash (on a 5-point scale))

<table>
<thead>
<tr>
<th>Presoaking time (hrs.)</th>
<th>Form</th>
<th>Color</th>
<th>Odor</th>
<th>Texture</th>
<th>Flavor</th>
<th>General Acceptability</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1.5</td>
<td>1.7</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1.5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Three methods of using the peppers were scored. A puree of the pepper pulp was thickened slightly, salted, and used as a sauce for a cheese omelet. Peeled whole peppers were sautéed in olive oil and were also used with tomatoes and onion in making a sauce. The judges preferred the tomato sauce to the other products. They thought this was very good and would be well received by most people. The sauté was not liked by any of the judges. The grayed green color was rated as fair, but they considered the product poor in form, texture, flavor, odor and acceptability. One judge thought it had a bitter or off flavor. The puree was slightly more acceptable, but not generally liked. The judges objected to the flavor, and suggested that further seasoning might improve the product. They found a modified product seasoned with lemon juice, spices and other condiments more acceptable, but no rating was assigned to this sauce.

TABLE VIII

Judges' Ratings of Bell Peppers
(on a 5-point scale)

<table>
<thead>
<tr>
<th>Product</th>
<th>Form</th>
<th>Color</th>
<th>Odor</th>
<th>Texture</th>
<th>Flavor</th>
<th>General Acceptability</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puree</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>1.7</td>
<td>2.3</td>
<td>3</td>
</tr>
<tr>
<td>Saute</td>
<td>2.3</td>
<td>3.3</td>
<td>2.3</td>
<td>2.3</td>
<td>2.3</td>
<td>1.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Sauce (tomato)</td>
<td>5</td>
<td>4.7</td>
<td>4.7</td>
<td>4.3</td>
<td>4</td>
<td>4.3</td>
<td>4.5</td>
</tr>
</tbody>
</table>
This study was undertaken to determine the suitability of green beans, Swiss chard, zucchini squash, and bell peppers for home dehydration. They were dried in a home dehydrator described in Oregon Agricultural Experiment Station Circular of Information No. 309. They were then stored in semidarkness in a cool storeroom for five months. Following this, they were rehydrated and cooked and the percentage of rehydration was calculated. The percentages for samples pre-soaked one hour and cooked until done were as follows: green beans, snapped, 35.7%; green beans, sliced, 42.9%; Swiss chard stems, 54.4%; zucchini squash, 41.2%; and bell peppers, 27%. The Swiss chard leaves were cooked without pre-soaking and showed 83.8% rehydration after boiling two minutes.

The flavor and consistency of all these vegetables was changed by dehydration and subsequent rehydration. Swiss chard, sliced beans, and bell peppers resulted in acceptable products, and snapped beans in a fairly acceptable product. Zucchini squash and chard stems were not satisfactory. Rehydrated snapped green beans were poor in form, but flavor was good, and when they were combined with other foods, their acceptability improved. They were considered to be a good product when cooked with tomatoes or served in a chowder. The beans which were sliced before dehydration
were much more acceptable by themselves, and merit further study. Swiss chard leaves rehydrated well and combined with other foods to form acceptable products. Work with the chard stems was discontinued because of their objectionable bitterness. The rehydrated zucchini squash was tasteless and unsightly. Bell peppers were accepted as seasoning for other foods, but were not liked when served alone.

Ascorbic acid determinations were made on the fresh and the dehydrated material to determine the relative amount of vitamin C retained. This retention was poor. Green beans retained but 5% of their original value, and Swiss chard 12%. Comparisons could not be made for bell peppers, as figures on the fresh material were not available. The content was low, however, (6.4 mg. per 100 grams of material on fresh weight basis) and considering the small amount usually eaten, these would be as poor a source of ascorbic acid as the green beans and Swiss chard.
CONCLUSIONS

1. During dehydration and rehydration, changes of appearance, flavor and texture took place in all of these vegetables. They were not comparable to the fresh vegetables, but with the exception of zucchini squash they were edible and fairly acceptable.

2. Sliced green beans, Swiss chard leaves, and bell peppers were dehydrated with fair success. Snapped green beans were less successful than the sliced ones because of their poor form. Swiss chard stems and zucchini squash were not successfully dehydrated.

3. Appearance, flavor, and acceptability of the vegetables were improved by seasoning, and by combining them with other foods.

4. The ascorbic acid retention was poor. These home dehydrated vegetables could not be relied upon as sources of vitamin C.

5. A matter for further study might be to determine whether the differences noted between the snapped and sliced beans would be obtained with other varieties and under other conditions.


Recipes

**Green beans**
Cover one cup of dehydrated beans with two and one half cups of boiling water and soak for one hour. Using the soaking water for cooking, bring the beans quickly to the boiling point, and boil gently for eight to ten minutes. Longer cooking produces a stronger flavor, but does not make the beans more tender. Season or combine with other foods before serving. Yield: two cups of beans.

**Green Beans with Tomato Sauce**

2 c cooked beans and cooking water to cover

1-1/3 c strained tomato or tomato juice

1/4 c finely sliced onion

1 Tb fat

1 t salt

Pepper if desired

Saute onion in fat until limp and transparent. Add the other ingredients and cook gently five to ten minutes, or until the tomato sauce is a desirable consistency. Yield: four to five servings.

**Green Beans with Bacon**

2 c cooked beans and cooking water to cover

1/4 c sliced or minced onion

2 slices of bacon, minced

1/2 t salt

Pepper if desired

Saute bacon and onion until lightly browned. Add beans, cooking water, salt and pepper. Cook slowly until water has nearly evaporated. Yield: 4 servings.
Green Bean and Salmon Chowder

1 strip bacon, diced  1 t salt
1 small onion, sliced  1 c flaked cooked salmon
1 1/2 c potato cubes  1 1/2 c cooked beans
1 1/2 c boiling water  1 c milk

Saute bacon and onions until a golden brown. Add potatoes and boiling water, and cook until potatoes are tender. Add remaining ingredients, heat to boiling and serve. Yield: 4 servings.

Swiss chard

Cover one cup of broken leaves with one and one half cups of boiling water. Gently boil for two minutes, drain and season. Yield: 1 c cooked chard. Chard measured after the leaves have been rubbed to a coarse powder yields two to three times its volume in cooked chard.

Buttered Chard

2 c cooked chard  1/4 c minced onion
1 Tb butter  1/2 t salt

Saute onion in butter until lightly browned, add other ingredients, mix well and serve hot.

Cream of Chard Soup

2 c chicken or veal stock  2 Tb minced carrot
1/2 t salt  1 c milk
1/4 c dry leaves rubbed fine  2 Tb butter
2 Tb minced onion  1 Tb flour
Saute onion in one tablespoon of butter. Add with carrot and dry chard leaves to the boiling salted stock. Cook gently until vegetables are tender. Melt the other tablespoon of butter, combine with flour and add milk. Cook this until the mixture has thickened, and add to the hot stock and vegetables. Serve at once. Yield: 4 servings.

**Bell peppers**

Cover one cup of dehydrated peppers with two cups of boiling water and soak for one hour. Using the soaking water for cooking, bring the peppers quickly to the boiling point, and boil gently for five minutes. Cool in cooking water, and remove the skins which are thin and papery. For a puree, the peppers may be rubbed through a sieve. Yield: one cup of pepper pulp.

**Pepper and Tomato Sauce**

1/3 c of cooked peppers, peeled and chopped
2 c strained tomatoes
1/3 c cooking water from peppers

1/4 c minced onion
1 t salt
bay leaf
pepper if desired

Combine ingredients and cook ten to twenty minutes, or until flavors are well blended. Remove bay leaf after ten minutes. Yield: two cups sauce.

**Spiced Pepper Puree Sauce**

1/2 c puree (made by rubbing drained pepper pulp through a fine sieve)
1 c cooking water from peppers
1 c water
1 t fat

1 t salt
2 Tb brown sugar
1/2 t Worcestershire sauce
1/4 t Tobasco sauce
1 t cornstarch

Juice 2 lemons (½ c)

½ t each: ginger, mace, cloves, pepper

1 med. onion, sliced

Combine all ingredients, and cook slowly until onion is tender, and flavors are blended. Onion slices may be removed, if desired.