WE GET many letters from people who ask whether foods lose much of their nutritive value in the stages between the farm and the table and how their nutrients can be conserved. The answers vary with the food in question.

Losses begin to occur after harvest or slaughter and are of two kinds.

The first is the obvious physical loss that comes when edible parts, like the outer leaves of plants and the fat of meat, are removed.

The second is the chemical loss that follows the changes in the structure of plant or animal tissue. Because respiration and activity of enzymes continue after production, the texture and vitamin content of some foods deteriorate rapidly, especially if the temperature around them is not right.

The importance of the loss depends partly on its extent and partly on the value of a food as a source of the nutrient in question. For example, pasteurization causes the loss of a large proportion of the ascorbic acid in milk. The loss can be ignored, however, because milk has relatively little ascorbic acid, and we do not depend on it for that vitamin as we do on fresh fruit and vegetables, which contribute about 90 percent of ascorbic acid (vitamin C) to our diets.

Ascorbic acid is lost more easily from most foods than other important nutrients are. It is subject to chemical destruction, and it is soluble in water.

In research on changes in nutrient composition of foods, ascorbic acid is the vitamin frequently studied, because measures that protect it usually also protect other water-soluble and heat-sensitive nutrients.

Some vegetables retain ascorbic acid very well for several days after harvest if they are chilled rapidly under vacuum and packed in crushed ice. Other vegetables have excellent retention at higher temperatures and lower humidity. These seemingly simple facts have had far-reaching implications in the handling of foods for the market and in the care of foods in the home.

The temperature, percentage of humidity, length of the storage period, method of handling to prevent physical injury, method of preparation for serv-
ing, and (in some foods) exposure to light are among the factors to keep in mind in considering losses and retentions of nutritive value of foods.

**Fresh vegetables**, such as kale, spinach, turnip greens, chard, broccoli, and salad greens, need to be refrigerated as soon as possible. They keep their nutrients best near freezing and at high humidity.

Leafy, dark-green vegetables and broccoli keep practically all of their ascorbic acid for several days if they are packed in crushed ice. They retain about half of it after 5 days in the refrigerator at 40° to 50° F. Although this represents a large proportional loss, deep-green leaves have such high initial values that they remain excellent sources of ascorbic acid and vitamin A even after this substantial loss. They could be expected to provide more vitamins C and A than freshly harvested snap beans and head lettuce—perhaps more even than tomatoes.

Cabbage is a more stable source of ascorbic acid than most leafy vegetables. Kept in cold storage under 40°, it retains three-fourths or more of its vitamin C as long as 2 months.

Cabbage should not be allowed to dry out. If it is to be held at home for a few days, it should be wrapped or put in a special compartment where the humidity is high. Cabbage holds its vitamin C well for a few days even at room temperature (usually considered to be 65° to 80°).

Among other vegetables that also retain their ascorbic acid well at room temperature and do not require high humidity are a number that stem from tropical plants, like peppers (a rich source of vitamin C), snap beans, lima beans, and tomatoes.

The ascorbic acid in tomatoes vine ripened out of doors in summer sunlight is double that in those grown in greenhouses in winter. Green tomatoes just beginning to turn color also are a good source if they have been exposed to full sun; they may have more vitamin C than red tomatoes from the same plant that ripened under foliage.

Tomatoes picked before they turn red do not reach their best in appearance and nutritive value either on a hot window sill or in the refrigerator. The bright-red color does not develop when the temperature goes above 85° for very long. A temperature between 60° and 75° is desirable. Tomatoes become soft, watery, and easily subject to decay when they are ripened in the refrigerator.

Firm, ripe tomatoes can be held at room temperature several days, probably a week, without loss of ascorbic acid. They lose their value rapidly as soon as they become overripe.

Fresh strawberries are such a good source of ascorbic acid that a handful direct from the patch would supply a man his entire day's need of vitamin C.

Berries generally are highly perishable and lose much of their ascorbic acid quickly if capped or stemmed or if their tissue becomes bruised. Berries to be held a few days must be kept cold, dry, and whole to retain their maximum values.

Oranges, grapefruit, lemons, limes, and tangerines have a high initial content of vitamin C, and it is well retained under many conditions. Citrus fruits when whole keep well several days without refrigeration.

Orange juice, whether it is freshly squeezed, or canned, or reconstituted from frozen concentrate or dehydrated crystals, retains most of its ascorbic acid for several days in the refrigerator. A few hours outside the refrigerator will not result in serious loss. A change in flavor would occur before much of the vitamin value is lost.

For practical purposes, foods usually are kept covered, but a lid on the orange juice container makes no important difference in the retention of vitamin C. There is no harm in keeping canned juice in the can until it is used up.

There is a loss of edible material—and therefore nutritive value—when oranges are squeezed and the juice is strained. The edible yield of the orange
CONSERVING NUTRITIVE VALUES

as strained juice is only about two-thirds to three-fourths that of the orange eaten by sections. Babies need the juice strained, but others get much more value from the orange used in other ways.

Carrots, sweetpotatoes, potatoes, and other roots and tubers retain their most important nutrients reasonably well outside the refrigerator if kept cool and moist enough to prevent withering. They spoil quickly when they are in direct contact with water. Condensation moisture should not be allowed to drop on them. They may be kept in a root cellar; a cool, well-ventilated basement in summer; or an unheated pantry or garage. Information on building simple storage facilities for maintaining good eating qualities of specific fruits and vegetables is available in publications that can be had by addressing the Office of Information, the United States Department of Agriculture.

Carrots and sweetpotatoes are unique among these roots and tubers for their high content of carotene. Carotene, often referred to as provitamin A, is a substance in plant foods that the body can convert to vitamin A. Hence, we speak of vitamin A value. This term, "vitamin A value," may refer to vitamin A itself or to its precursors, among them beta carotene.

Carrots have carotene as their most important nutrient. Removing the tops does not affect their vitamin A value. Sweetpotatoes of the deep orange-colored varieties are important sources of carotene. The content is high initially; it increases during the usual period of storage before sweetpotatoes reach the retail market. The carotene content drops gradually after 6 months. Few sweetpotatoes are stored that long.

Potatoes, parsnips, turnips, and sweetpotatoes are not rich in ascorbic acid but nonetheless may be vital sources of it.

Freshly dug potatoes are highest in ascorbic acid. Immature potatoes have more than those left to mature. The loss of ascorbic acid is progressive throughout the storage period, but is most rapid during the early weeks. About half is left after 3 months of storage. Potatoes still retain about one-third of their original content after 6 months.

Potatoes develop an undesirable sweet flavor when held a long time at a few degrees above freezing. Such chilling does not impair their nutrient content, and their bland flavor returns if they are brought to room temperature or just below for a few days.

Potatoes exposed to strong light may develop green spots. Since there is some question of toxicity associated with the pigmented area, it is advisable to discard the green-colored parts.

Ascorbic acid behavior in sweetpotatoes follows the pattern of greater losses in the early months of storage and more gradual loss later. At the end of 3 months in storage, when about 75 percent of the crop has reached the consumer, 30 to 50 percent of the original content of ascorbic acid is lost. Another 10 percent is lost by the end of 6 months.

CANNING is one of the most familiar forms of food preservation. This means of preserving fruits, vegetables, and meats by partial cooking or another process and sealing them in tin cans, glass jars, and other containers originated more than 150 years ago.

Foods lose some value during the canning process and afterward throughout the storage period.

Newer techniques have succeeded in reducing losses of nutrients in canning and improving the quality of canned food. A short-time, high-temperature process, followed by rapid cooling, is superior to the conventional method of holding the foods at lower temperatures for longer periods.

Expulsion of air before sealing and processing reduces oxidative losses of vitamins at high temperatures.

Continuous agitation of cans reduces processing time and prevents overcooking of food near the can wall; thus the additional losses of vitamins,
inevitable in the older method, are avoided.

Canned meats lose some of their thiamine during storage. Pork luncheon meat may lose about 20 percent by the end of 3 months and 30 percent by the end of 6 months when it is stored at 70°. Losses of thiamine increase at higher temperatures. Riboflavin, another vitamin of which meat is a good source, is not affected by ordinary storage temperatures.

Canned vegetables stored at 65° lose up to 15 percent of their thiamine in a year; stored at 80°, the losses increase to about 25 percent.

Canned fruits and vegetables have small losses of ascorbic acid when stored at 65°. Losses are about 2 to 7 percent after 4 months and increase gradually to about 10 percent by the end of the year. When, however, the storage temperature is 80°, losses range up to 15 percent after 4 months; up to 20 percent after 8 months; and up to 25 percent after a year.

Carotene is retained well in canned fruits and vegetables. Losses average about 10 percent in a year when stored at 80°. Tomato juice is a particularly stable, year-round source of carotene.

Usually the drained solids in canned vegetables make up about two-thirds of the total contents of the can. Soon after canning, the nutrients in the vegetable that are soluble in water distribute themselves evenly throughout the solids and the liquid. The solids thus retain about two-thirds of the soluble nutrients, and the other third may be in the liquid.

FREEZING, a relatively new way to preserve food, offers much in the way of retaining nutrients and eating qualities of foods.

Frozen foods undergo some nutritive losses. The ascorbic acid in the freshly gathered vegetable is reduced during the blanching process before freezing. There is small loss of other watersoluble vitamins and some minerals as well if the blanching is done in water.

Frozen foods should be transferred to the home freezer or freezing unit of the refrigerator as quickly as possible after they are bought at the market. Thawing and refreezing adversely affect the content of ascorbic acid and the flavor.

Most frozen foods should be held well below the freezing point for best retention of ascorbic acid. Acid foods hold their vitamin C remarkably well. Frozen concentrated orange juice, for example, held only to freezing, 32°, loses no more than 5 percent in a year.

Most frozen foods, however, when held only at the freezing point, show progressive loss. At zero, frozen beans, broccoli, cauliflower, and spinach lose one-third to three-fourths of their ascorbic acid in a year but only a little at —20°.

To obtain the best ascorbic acid value and highest quality in commercially frozen foods, it may be necessary to buy in smaller quantities and replenish supplies oftener unless the home freezer can be maintained below zero.

Frozen foods on hand after several months of storage may have lost a considerable part of their ascorbic acid. If they were such excellent sources as broccoli, kale, and cauliflower to begin with, however, they would still be good sources.

The nutrients other than ascorbic acid in frozen foods probably are not adversely affected by temperatures only as low as freezing. Therefore home-frozen supplies that cannot be held at the low temperatures most desirable for retaining the maximum content of ascorbic acid should not be overly discounted.

PASTEURIZATION of raw milk is a necessary safeguard. It does not free milk entirely of bacteria, but it destroys those that cause diphtheria, tuberculosis, typhoid, undulant fever, and other diseases. Loss of nutrients through pasteurization is insignificant compared to the safety it provides.

Pasteurization does not affect ma-
ConserVing Nutritive Values

terially the main contribution of milk and milk products to the diet—that is, the calcium, protein, riboflavin, and vitamin A. The losses induced by heating are chiefly in the vitamins ascorbic acid and thiamine—losses that easily can be made up in a diet composed of a good variety from several other groups of food.

Milk and milk products provide about two-thirds of the total calcium in our diets, nearly half the riboflavin, and more than a fifth of the protein. Calcium and protein are well retained in milk.

Riboflavin in milk is reduced by exposure to direct sunlight, daylight, or artificial light. The rate of destruction is affected by the intensity of the light, length of the exposure, and the temperature of the milk.

The total loss of riboflavin from the time of production until the milk is served need not be large if it is handled properly—if it is kept clean and cold and out of direct sunlight.

Milk under artificial light in refrigerated showcases loses little of its riboflavin. The milk there is cold, and the light bulbs usually are of low intensity. If the showcase is near a window so that the milk is exposed to considerable daylight, however, losses could increase enough to be important.

Milk delivered on the doorstep should be protected from light quickly. Within the first 5 minutes there is little loss of riboflavin from milk exposed to the sun in clear-glass quart bottles. By the end of 30 minutes, losses are about 10 percent. They reach about 40 percent after 2 hours, even when the temperature of the milk does not rise above 70°. The loss increases as the milk warms.

The size and type of container are related to retention of riboflavin. Milk in half-pint bottles loses about twice as much as milk in 2-quart bottles. Paper containers and brown glass provide several times as much protection to the riboflavin as clear glass.

Fresh eggs can be kept in cold storage or in the refrigerator for long periods without serious loss of nutritive value—although cold storage of eggs has become an uncommon practice.

Some transfer of water and nutrients may take place between white and yolk during storage, but eggs tested after 18 months of cold storage showed no loss of protein. Changes in flavor and in cooking properties probably occur before the eggs lose their more important nutrients—riboflavin, iron, and vitamin A.

Dried eggs are a good source of the same nutrients important in shell eggs. Dehydration itself does not reduce the values for protein, vitamin A, or riboflavin, but loss of vitamin A value occurs under some conditions of storage.

Dried eggs should be kept cold, preferably below refrigerator temperatures, and in a tightly closed container that gives protection against air and moisture. Dehydrated eggs lose a third of their vitamin A value in 6 months and about two-thirds in 9 months when stored at ordinary room temperature. The losses are accelerated at higher temperatures. Nearly two-thirds of the vitamin A value is lost after 3 months of storage near 100°.

Small progressive losses in riboflavin occur in dehydrated eggs. They amount to about 10 percent after 9 months at room temperature and 15 percent when stored near 100°.

Protein, iron, and the B vitamins, notably thiamine and niacin, are among the chief contributions of cereals to the diet. The minerals and vitamins are more highly concentrated in the germ and outer layers than in the inner portions of the grain. Cereal grains undergo fairly sizable physical losses when they are processed into the forms we use most. The nutritive losses are directly related to the physical losses. The kind and extent of processing determine the proportions of nutrients remaining in the finished product.

Milling wheat for white flour for
breadmaking and for general home use involves removing some 28 to 37 percent of the weight of the kernel. Even more is removed for very highly refined cake flours. About 72 pounds of straight-grade white flour are obtained from 100 pounds of cleaned hard wheat. This amount of flour has about a third of the amount of iron in the unmilled kernel, about a fourth of the thiamine and niacin, and about a third of the pantothenic acid, another important B vitamin in cereals.

Losses in milling are even higher for some less familiar nutrients. For example, vitamin E is present in high concentrations in the oil of wheat germ. Nearly all of this vitamin is removed with the germ and outer layers of the wheat kernel in the milling of white flour. The importance of the loss cannot be estimated until more is known about the role of vitamin E in human metabolism.

Rice and other cereal grains also lose much of their nutrients in milling. The highly milled, polished rice commonly referred to as white rice contains smaller amounts of iron and the B vitamins than either parboiled or brown rice. Brown rice has the value of the whole grain.

Parboiled rice, also called converted rice, is prepared by a special adaptation of the milling process whereby it retains much more iron and vitamins than ordinary white rice, although it looks like white rice. The nutritive value of parboiled rice is intermediate between regular white rice and brown rice.

Whole-grain or nearly whole-grain forms of cereals are available generally. Among them are whole-wheat flour, sometimes called graham flour, brown rice, dark rye flour, and whole-ground cornmeal. They retain the germ and outer layers and thus the high nutritive values of these portions. They are preferred by many for their flavor and the roughage they provide.

Craftsmanship in the kitchen transforms the food at hand into meals the family enjoys and keeps nutritive values in the food.

Foods must be trimmed or otherwise prepared. Many must be cooked. Surplus portions must be properly cared for. Leftovers must be made use of. Such skills in the home determine whether a family is well fed or only well filled.

Trimming is necessary for damaged leaves, bruised spots, infected portions, and other inedible material. Trimming may be desirable to discard parts like coarse leaves or excess fat. Discarding any amount of food, however, reduces the nutrients originally present.

Vegetables almost always need a little trimming. Different parts of the plant differ in nutrient content. Stems are more fibrous than the leaf blades they support. The blade is rich in many nutrients. The outer leaves are coarser and contain higher concentrations of vitamins and minerals than the more tender leaves and buds they protect.

The leafy part of collard greens has about 30 times more vitamin A value than the midrib. Turnip greens have more than 20 times as much vitamin A value in the leafy part as in the midrib. The pale color of the stems and midribs of kale and of various other leafy vegetables in comparison with the dark-green color of the leaf indicates that these vegetables also have most of their vitamin A value in the thin part of the leaf, which often contains many times more vitamin C than the stems and two to four times more iron.

Stems and midribs account for nearly half the weight of the leafy vegetable. They may be discarded with little loss of nutrients. If these fibrous parts are removed from turnip greens, less than 5 percent of the vitamin A value of the whole leaf is removed. Such trimming is worth while if it increases acceptability of the more nutritious parts.

Trimming broccoli, head lettuce, and cabbage usually involves discarding the more nutritious parts. Dark-green outer leaves of lettuce are as
CONSERVING NUTRITIVE VALUES

much as 30 times higher in vitamin A value than the inner bleached leaves. The darker leaves might make up 10 percent of the weight of a particular head of lettuce. If those leaves are not used, more than three-fourths of the vitamin A value of the whole head would be lost.

Broccoli leaves are edible and have about 20 times as much vitamin A value as the stalks and several times as much as the flower bud. If these outer parts are tender enough to use when the vegetable is brought home, they should be chilled and kept moist until they can be used. Losses of vitamins and minerals are disproportionately higher if the outer leaves wilt and toughen and must be discarded. They may appear to revive if they are put in cold water for a time, but vitamins already destroyed cannot be regained.

Meat, poultry, and fish provide protein, fat, minerals, and many soluble nutrients, including the B vitamins, riboflavin, thiamine, and niacin.

Washing or long soaking of meats and poultry may result in significant loss of nutritive value and flavor. Wiping with a damp cloth is sufficient. Water should not be used directly on frozen forms of these foods to hasten thawing.

Cooking is a refinement that has many advantages and some hazards in keeping the values in foods.

Cooking improves the palatability of some foods, improves the digestibility of fibrous foods, and sometimes is a safeguard against disease-producing organisms. Pork, for example, should always be well cooked to avoid the danger of trichinosis. Beef should be cooked at least to the rare-done stage (140°) to avoid danger of cysticercosis.

Cooking speeds the loss of some nutrients. It concentrates others—mainly by removing moisture and fat.

Ascorbic acid, all the B vitamins, and some of the mineral compounds are soluble in water.

The amount of water used, the length of the cooking period, and the amount of surface area exposed are of special importance in retaining these nutrients.

The three R’s of cooking to conserve nutrients are: Reduce the amount of water used; reduce the length of cooking period; reduce the amount of surface area exposed.

The volume of water used in cooking is most important.

If vegetables are cooked in a large amount of water—more water than vegetable—the loss of nutrients through solubility will be greater than when the volume of water is small. Cabbage cooked quickly in about one-third as much water as cabbage retains nearly 90 percent of its vitamin C; cooked in four times as much water as cabbage, it retains less than half. Broccoli, frozen or raw, cooked quickly in a small amount of water, loses only half as much vitamin C as when cooked in excess water.

Much of the vitamin C loss can be recovered if the cooking liquid (pot liquor) is used along with the vegetables. If served at a later meal, the liquid contributes the minerals it has in solution, but some of the ascorbic acid and thiamine in the liquid are destroyed on standing and reheating.

The longer a food is cooked, the greater is the destruction of nutrients in it. If a vegetable is started in cold water, fairly large losses of ascorbic acid occur before the water begins to boil. This loss is attributed to enzyme activity, which perhaps is increased during the first part of the heating period and stopped when the heat reaches the temperature, below boiling, at which the enzymes are destroyed. This critical period and the total cooking time are shortened if the water is boiling when the vegetable is added.

Cutting or shredding foods permits greater oxidative destruction at the cut surface. It also permits greater extraction of nutrients in the cooking water. Because cut pieces cook more quickly than if left whole, the adverse
effects of extra surface exposure may be offset, at least partly, by the shortened cooking period.

Methods for cooking vegetables to conserve their nutrients are steaming, pressure cooking, and cooking quickly in a tightly covered pan with only enough water to prevent scorching. Ascorbic acid losses can be held to a minimum if the vegetable is cooked by any of these methods only until done.

Baking is satisfactory for potatoes and sweetpotatoes and for a few other vegetables that require long cooking. We do not discuss it with the other methods here because it is seldom used for most vegetables and quite probably would cause considerable nutritive destruction.

Waterless cooking is not necessarily superior to other methods. The term is a misnomer, as the method depends on juice extracted from vegetables and on any clinging rinse water. The method does not permit quick cooking, and the advantage of using little or no added water may be canceled by the longer cooking period.

Expensive equipment is not essential for cooking foods to conserve their nutrients. Any utensil that has a lid that fits the top and is heavy enough to prevent vapor and steam from escaping to any extent is suitable for cooking with a minimum amount of added water.

The material (aluminum, enamel, glass, stainless steel) used in the construction of the cooking utensil is not important. Copper in direct contact with food would hasten the oxidation of ascorbic acid, but copper pans have practically become collectors' items. Modern pans having copper-plated bottoms have another metal covering the inside surface.

There is no scientific basis for the idea that aluminum pans are injurious to health.

Meats shrink in weight and volume as they cook, and they become more concentrated sources of some nutrients. They also lose some nutrients. Much of the total loss is water, which goes off mainly through evaporation, although some usually is in the drippings. The greater the water loss, the drier the meat will be and the greater the concentration of nutrients that remain.

The fat that is lost becomes part of the drippings and would be eaten if the drippings were used in gravy or for other food purposes. Fat spatters and burns easily, and some fat may be completely lost if the meat is cooked at high temperatures.

Protein in meat is not destroyed by cooking, and only small amounts go into the drippings. The loss of protein is unimportant when meat is cooked without added water. Even when meats are stewed or cooked otherwise in large amounts of water, only about 10 percent of the protein goes from the meat into the broth.

The caloric value and the protein and fat content of any piece of meat depend first on the composition of the raw meat and then on such factors as the degree of doneness at which the cooking is stopped, the temperature at which the cooking is done, and the method (roasting, braising, stewing) that is used.

A roast of beef can be used for illustration. Let us say that this particular one is without bone and has about 20 percent (one-fifth) fat, which could be trimmed off but is still on the roast. If the roast is cooked to a medium stage of doneness at moderate oven temperatures, it would be expected to lose about one-fourth of its weight when raw. A 2-ounce slice of the cooked roast would have about 14 grams of protein and 13 grams of fat and would furnish about 175 Calories.

If the same roast before cooking had all the fat removed that could be cut off with a knife and were cooked at the same temperature also to medium doneness, a 2-ounce slice would have about 16 grams of protein and only 3 grams of fat and would furnish about 95 Calories.

If the roast had been cooked only to the rare-done stage, the water con-
CONSERVING NUTRITIVE VALUES

tent would be higher than at medium doneness, and there would be less protein and fewer Calories in a 2-ounce slice.

Vitamin losses in meat are related to cooking conditions. The B vitamins (thiamine, riboflavin, and niacin) are soluble. The meat juices carry some of them into the drippings as the meat cooks.

Riboflavin losses are usually 10 to 15 percent. Niacin losses are 10 to 40 percent.

An additional loss of thiamine is due to destruction by heat. A braised roast may lose more than half its thiamine content, but a medium-done oven roast may lose only about a third to half of its original content.

Searing or browning of meat, often practiced at the beginning of the cooking period, induces some thiamine loss. Well-done roasts appear to lose more thiamine than those cooked rare or medium done.

It is difficult to generalize about nutrient retentions by various cooking methods.

On one point there is general agreement. Meat drippings contain significant amounts of the water-soluble nutrients—the drippings from thawing frozen meat; the drippings from cooking meat, particularly in braising and stewing; and the juices released by slicing meat. If the water portions of the drippings cannot be served with the foods, they could be saved for flavoring or used in other ways.

Since about one-third of the water-soluble nutrients in canned vegetables are in the liquid, it is desirable that the liquid be used. This may be done in various ways. Some boil down the liquid before adding the vegetable. Others consume the liquid hot as an appetizer, particularly in winter. Others save it to use in soups and gravies. In any case, it should be used as quickly as possible to avoid the losses of holding.

LEFTOVERS and food cooked in advance for later meals may save time, but this saving is at the expense of nutrients.

Cooked vegetables show losses of ascorbic acid that progress with the length of time that they are kept. They have about three-fourths as much ascorbic acid after 1 day in the refrigerator as when freshly cooked. They have about two-thirds as much after 2 days.

Reheating takes another toll of ascorbic acid, so that cooked vegetables reheated after 2 or 3 days in the refrigerator can be counted on for only one-third to one-half as much ascorbic acid as when freshly prepared.

Smaller but significant losses of thiamine occur in meats that are held and reheated. Probably there is no thiamine or other nutrient loss from the roast if it is served cold.

Eggs should be cooked. Raw eggs are not sterile and occasionally carry Salmonella, one of the pathogenic bacteria. Raw eggs contain avidin, a protein material that can combine with the B vitamin, biotin, causing the vitamin to be unavailable to the body. Cooking renders avidin inactive.

Eggs do not lose much nutritive value when they are cooked, probably because the cooking period is short and fairly low temperatures are used.

Poached and fried eggs may lose about 15 percent of the riboflavin in the raw egg. Prepared other ways, they lose less. Thiamine losses—15 percent—are about the same for all methods of preparation.

Cereals, by way of their flours and meals, lend themselves to a greater variety of cooking uses than perhaps any other type of food. Wheat, corn, rice, oats, and rye become myriad food items.

We have breakfast foods, macaroni and other pastes, cakes, doughnuts, puddings, pastries, cornbread, mush, hoecake, griddlecakes, loaves, rolls, biscuits (to name but a few) and that great American institution, hot toast.

Cereal products as a group are good sources of several nutrients, especially protein, iron, and the B vitamins.
Cereals and their products are cooked in many different ways. Nutritive losses probably occur in all the methods, but some are small. The most important loss is in thiamine, which is subject to destruction by heat and is also soluble in water.

A characteristic of cereal cooking is absorption of water, which has the effect of dilution of the nutrients. This is not a loss, however, as the nutrients are simply distributed in the greater volume and weight of the cooked product.

Baking is one of the commonest forms of cooking cereal products.

In baking, the retention of thiamine varies with the product, but is affected generally by the length of the cooking period, the temperature, the amount of surface area exposed, and the amount of baking powder or soda.

Bread baked to medium brownness loses about 20 percent of the thiamine in the ingredients. Bread removed when the crust is light loses less, about 17 percent; when quite dark, it loses about 25 percent.

Rolls baked to the usual degree of brownness lose only about 15 percent of thiamine — somewhat less than bread. The shorter baking time required for rolls more than compensates for the greater surface area exposed to heat.

Quick breads, like biscuits and muffins, made with baking powder as the leavening agent, lose about 20 to 25 percent of the thiamine in their ingredients. Increasing the amount of the baking powder by half increases the loss of thiamine to about 25 to 30 percent.

Cakes made at home lose about 20 to 30 percent of the thiamine of the original ingredients. Cakes may lose as little as 10 percent and as much as 35 percent, depending on the bulk and the temperature and length of the baking period.

Cornbread made with soda and sour milk retains thiamine reasonably well, unless more soda than necessary is used. Excess alkali from the soda has an adverse effect on thiamine retention. As with other baked goods, the thiamine retention is higher when the proportion of crumb to crust is greater. Baking cornbread in a loaf pan results in higher retention than baking in corn sticks because of the greater proportion of crumb to crust in the loaf than in the sticks.

A study at the Texas Agricultural Experiment Station showed the average retentions in corn loaves, muffins, and sticks as 85 percent, 79 percent, and 66 percent, respectively, when the proportion of crust was 30 percent, 40 percent, and 68 percent.

Toasting reduces the thiamine content of bread about 15 to 20 percent. The thinner the slice, the greater the heat penetration and the greater the destruction. One comparison showed a toasted thin slice as losing 31 percent and a thick slice losing only 13 percent.

Riboflavin is not greatly affected by heat but is sensitive to light. Usual good housekeeping practices for keeping cereals include covering them to prevent either drying out or taking up moisture. Such protection would ordinarily reduce the exposure to light and thus prevent the loss of riboflavin.

Clear Cellophane and translucent wax papers are used for packaging many items. Some products, as vienna bread, do not usually have a wrapper. A large percentage loss of riboflavin in these products could be important, especially in enriched products, because they are particularly good sources of this light-sensitive vitamin.

Experimental studies have been made of the loss of riboflavin in such commercial products as bread, unwrapped and wrapped in translucent and in opaque coverings; and partially baked rolls, some unwrapped and some covered with clear Cellophane. The rolls used in these studies had not been baked long enough to develop any surface color or any appreciable amount of crust.

The experiments showed that 1-pound loaves of the enriched bread
wrapped in heavy wax paper retained riboflavin well for as long as a week when exposed to artificial light or to bright sunlight in winter. Losses did not occur in unwrapped bread until 3 days when the bread was exposed to strong artificial light. By the end of the first day in the sun, however, there was a loss of about 10 percent.

The riboflavin losses in the partly baked rolls, unwrapped or covered with Cellophane, were somewhat higher than in the baked breads. Strong artificial light induced small losses by the end of the first day. Sunlight induced losses of about 30 percent or more.

These studies indicate that reasonable protection from light, such as that afforded by a translucent covering like heavy wax paper, permits excellent retention of riboflavin in bread.

Bakery products wrapped in clear Cellophane and distributed commercially probably do not undergo the larger losses of the more drastic experimental conditions. The light that reaches the products stacked on the grocer's shelves may be subdued enough to cause no serious loss of riboflavin during the time the products are there.

Cereals cooked in only enough water to be absorbed lose only small amounts of thiamine—probably 5 to 10 percent.

Such products as macaroni, other Italian pastes, and rice lose some of their thiamine by heat destruction in cooking. When they are cooked in an excessive amount of water, they also lose fairly large portions of the remaining thiamine and other water-soluble nutrients when the cooking water is thrown away.

The handling of rice has changed considerably in recent years. It was once sold from bins in the stores, and it had to be washed. Some people still wash rice, although for the cleaned packaged rice of today washing is unnecessary and nutritionally expensive.

Washing once before cooking can cause a thiamine loss of 10 percent in brown and converted white rice and 25 percent in regular white rice. After changing water three times, the loss of thiamine may increase to 53 percent in white rice, 20 percent in brown rice, and 10 percent in parboiled rice. The loss of riboflavin and niacin is not so great—10 to 15 percent.

Cooking rice by boiling in an excessive amount of water and discarding the cooking water leads to high losses of nutrients in all types of rice. The loss of B vitamins is roughly proportional to the volume of water used and the amount of water drained off.

If a poor cooking method is used, such as cooking 1 cup in 8 to 10 cups of water and draining the cooking water and rinsing afterward, the loss is about one-third of the original thiamine in the white and enriched rice. Rice cooked in the top of a double boiler with a minimum amount of water, until all the water is absorbed, with no rinsing afterward, loses 10 to 20 percent of the thiamine and less than 10 percent of the riboflavin and niacin. The use of a double boiler is desirable to avoid the high temperatures at the bottom surface of the cooking utensil, which tend to accelerate losses of vitamins.

Another good method is to bake the rice after just enough water is added to it in a casserole to produce a palatable but not too soft rice by the time the cooking water is absorbed. The loss of thiamine then is 10 to 30 percent, depending on whether the rice is washed once or not at all.

The label on some packages of rice says, "To retain vitamins, do not rinse before or drain after cooking." If that principle is followed in the preparation of rice for eating and if the amount of water used is just enough for absorption, the values will be well retained.

We have discussed some of the factors that affect the nutritive value of foods before and after they come into the home. Foods do indeed undergo nutritive losses, but all the time we are learning better ways to retain their original values.
Food crops and livestock products available throughout the year are abundant for the nutritive needs of all our population. With reasonable care all along the line from farm and ranch to the family meal, foods will retain much of their quality, flavor, and nutritive value.

Revolutionary changes are at hand in the processing and preparation of foods. The electronic oven, for example, is in use in some institutions and homes with a performance that is almost fantastic. Food is cooked by microwaves. A plate of food put into the oven is cooked in a few minutes. The food becomes hot, but the plate remains cool, except as it is heated by the food itself.

The effect on nutrients of this short-time cooking process is under study in many research laboratories. We cannot say what the findings will be, but it is certain that among the peacetime applications of energy in the atomic age will come methods for better retention of nutrients than our present good practices provide.

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Woot-Tsuen Wu Leung is a nutrition analyst with the Household Economics Research Branch. Formerly she served on the staff of the Foreign Economic Administration and the National Research Council. Dr. Leung has a degree from Lingnan University, Canton, China, and her doctorate from The Pennsylvania State University.

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**Home Freezers on Farms**

<table>
<thead>
<tr>
<th>Region</th>
<th>1950</th>
<th>1954</th>
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<tbody>
<tr>
<td>SOUTH</td>
<td>7%</td>
<td>23%</td>
</tr>
<tr>
<td>NORTH CENTRAL</td>
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<td>40%</td>
</tr>
<tr>
<td>WEST</td>
<td>17%</td>
<td>42%</td>
</tr>
<tr>
<td>NORTHEAST</td>
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<td>46%</td>
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**Food Baked at Home**

*Southern Farm Families, 1948 and 1955*

<table>
<thead>
<tr>
<th>Food</th>
<th>1948</th>
<th>1955</th>
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<tbody>
<tr>
<td>BREAD</td>
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<tr>
<td>PIE</td>
<td>94%</td>
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</tr>
<tr>
<td>BISCUITS</td>
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</tr>
<tr>
<td>CAKE</td>
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<td>75%</td>
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<tr>
<td>ROLLS</td>
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<td>19%</td>
</tr>
<tr>
<td>COOKIES</td>
<td>62%</td>
<td>37%</td>
</tr>
</tbody>
</table>