MEAT, POULTRY, EGGS
Quality in Processed Poultry

Alvin A. Klose, Helen L. Hanson, Edmund H. McNally

The economic disadvantages of transporting and marketing live poultry, the value of equalizing seasonal production by storage, and the trend toward making foods available on a ready-to-cook basis have all contributed to the expansion of production of frozen and canned poultry. Cold-storage stocks of poultry increased from 100 million pounds in 1931 to 300 million pounds in 1950. Much of the frozen chicken marketed now comes from the rapidly expanding commercial broiler industry. While the yearly farm production of chicken has remained very near 2,500 million pounds since 1930, commercial broiler production has increased from 96 million pounds in 1934 to 1,482 million pounds in 1949. Commercial broiler production, processing to obtain a packaged, eviscerated, cut-up product, and marketing in retail frozen-food display cases often are coordinated now into a continuous year-around operation. Greater economy, uniformity, and control of quality are some of its advantages.

In contrast to the stable level of production of farm chickens, turkey production increased from 228 million pounds in 1930 to 754 million pounds in 1949. That increase and the corresponding rise in consumption from 1.8 to 4.5 pounds per capita can be attributed mostly to more economical production through breeding, feeding, and disease control. Frozen storage has been an important factor in the growth of the turkey industry. The seasonal character of turkey production requires frozen storage to relieve the surplus in winter and provide adequate stocks throughout the year. Cold-storage stocks at the beginning of 1930 were 10 million pounds, compared to 127 million pounds in 1950.

Limitations in knowledge and facilities during the early years of the frozen-poultry industry resulted in inadequate storage stability. The term "cold storage" itself was linked sometimes with poor quality. Improper handling of eviscerated fowl for frozen storage sometimes produced bacterial contamination, and thus evisceration became questionable as a practice in the preparation of frozen poultry. Investigations since 1935 have altered some of the earlier views and have provided information on the requirements for many of the steps involved in producing satisfactory frozen poultry. The deteriorative changes in stored frozen poultry have become better understood, and their relation to processing and the storage procedures has been studied. More intensive investigations are needed on certain of the changes, such as oxidative rancidity in the poultry fat and structural changes in the meat protein, in order to develop economical methods for their prevention.

The frozen-poultry industry is in a period of active growth and change. The producer wants to increase per capita consumption by making poultry a year-around, everyday dish.
consumers have the constant desire for good-quality poultry, readily available in handy packages, competitively priced with other meats, and ready to cook with little preparation. Eviscerated, oven-ready birds, cut-up poultry, turkey steaks, precooked frozen poultry, and canned poultry are some answers to those desires.

**PROCESSING AND STORAGE**

Hazards are obviously related to the composition of the product. The edible part of the chicken carcass contains 65 percent water, 20 percent protein, 14 percent fat, and 1 percent ash. Evaporation of water from this tissue in frozen storage is serious whenever temperature differences develop between meat and surroundings and no moisture-vapor barrier is present. The first evidence of dehydration is around the feather follicles, where the appearance of small, lighter-colored rings is termed "pock marking." Where large areas of skin are involved, the general term "freezer burn" is applied. Loss of water equal to 1 to 3 percent of total weight is enough to produce a serious freezer burn. Evaporation from the surface of the skin may not be great enough to cause freezer burn and yet may result in small increases in the opacity of the outer layers of skin and a corresponding loss of the natural color of the freshly slaughtered fowl. A lack of juiciness sometimes noticed in frozen poultry has not been adequately characterized, but it may be related more closely to changes in the physical structure of the muscle protein than to dehydration.

One of the commonly recognized objectionable developments in stored poultry is rancidity, which is generally associated with changes brought about by oxidation of the fat. The rate at which fats exposed to air oxidize is related to the temperature, the effective concentration of oxygen present, and the composition of the fat or fatty tissue. Body fat from hens on normal diets contains about 26 percent palmitic acid, 7 percent stearic acid, 7 percent hexadecenoic acid, 38 percent oleic acid, and 21 percent linoleic acid. Of those acids, the last three are unsaturated—they tend to combine with elements, such as the oxygen of the atmosphere. The degree of unsaturation of poultry fat, an indication of its susceptibility to rancidity, is intermediate in the realm of natural fats, being less than that of highly unsaturated, unstable vegetable oils, such as linseed or soybean oil, but more than that of coconut oil and some animal fats. Turkey fat seems to be more susceptible to rancidity than chicken fat. Rancidity may develop in commercially stored frozen turkeys after 6 or 8 months of storage. It can be detected in the odor of the skin fat and exposed visceral fat of the uncooked bird, in the aroma during cooking, and in the fat and meat of the cooked carcass. In the first stages of oxidation, the concentration of peroxides in the fat, determined by chemical analysis, is a good index of the degree of rancidity.

"Visceral taint" is the term used to describe disagreeable odor and flavor in poultry meat due to the diffusion of obnoxious substances from the intestinal tract and other viscera into the meat. It is especially noticeable in dressed, uneviscerated birds that are held at chill temperatures (34° F. or higher) for several days.

Discoloration of bone and adjacent tissue of young chickens held in frozen storage has no effect on odor or flavor. It is due to diffusion of hemoglobin and its oxidation products out of the marrow of the relatively soft bones.

Problems of bacterial contamination in frozen poultry are closely linked with sanitation in dressing and evisceration and with storage conditions. The surface bacterial contamination of eviscerated poultry is largely of intestinal origin. Cutting up poultry before packaging may also introduce a large bacterial load. Gross bacterial growth on dressed birds held at relatively high temperatures results in the development of a green color, attributed to the oxidation of blood pigments.
The development of good meat-type chickens has been subordinated at times to breeding for high egg production. Several satisfactory breeds for broiler and fryer production have been developed, among them the New Hampshire, Barred and White Plymouth Rock, Cornish, and crosses among those breeds. An idea of the ideal meat-type bird can be obtained from the score cards in the Chicken-of-Tomorrow contest, sponsored by a chain of grocery stores. Equal weight was given to economy of production and quality of meat. The qualities scored for the 12-week-old chickens were: Egg production rate of parent flock; percentage of hatchability; percentage of livability; pounds of feed required to produce a pound of chicken at 12 weeks; average live weight at 12 weeks; completeness and uniformity of feathering; uniformity of size, type, and color; well-proportioned body; broad, long, full-meated breast; well-covered, straight keel bone; plump, full-meated thigh joint; full-meated, moderately short drumstick; wide, long, flat, well-fleshed back; few pin feathers; bright, soft, smooth-textured skin; little or no dark meat showing through the skin; entire carcass well covered with fat.

Requirements for a good commercial turkey are like those listed for chickens. Emphasis is on economical and rapid growth, high proportion of edible meat to carcass weight, and early feathering. The Broad-Breasted Bronze is probably the most popular breed. A separate small breed, the Beltsville Small White, has been developed at Beltsville by the Department of Agriculture in order to provide a bird for the small family. Rate of gain per pound of feed is less for the smaller breeds, but that disadvantage is offset by consumer preference for the lighter-weight turkeys. Also, the Beltsville Small White matures more quickly (24 weeks) than the Bronze (28 weeks).

The composition and stability of fat in the carcass of a bird depend on the amount and type of fat in the diet. Feeding fats containing relatively large amounts of linoleic acid, linolenic acid, or other unstable fatty acids results in the production of carcass fat with a much higher content of unstable fatty acids and hence a lower stability. Restricting the diet to no fats or to stable fats provides a slight increase in the content of the more stable fatty acids. Finishing rations therefore should not contain fish oils or other highly unsaturated oils.

V. S. Asmundson and others at the University of California demonstrated that 2 to 5 percent of fish oils (which are relatively unsaturated and hence unstable) in turkey rations fed for 6 weeks before slaughter produced off-flavor and off-odor in the cooked carcass. Good-grade fish meal at a level of 25 percent had no effect.

The finishing, or fattening, of poultry before slaughter adds fat to the carcass and quality to the flesh. W. A. Maw, at Macdonald College, compared the performance of corn, wheat, oats, and barley in the finishing of mature-bodied cockerels. Corn was somewhat the best in terms of percentage of fat in the flesh and flavor and texture of the cooked meat. The feed efficiency (pounds of gain per pound of feed) is greater the younger the bird and the shorter the finishing period. In order to get maximum finish and top-quality price, however, finishing must be carried on for 2 or 3 weeks on approximately mature-bodied birds.

The use of synthetic female sex hormones has been tried commercially. The wisdom of the practice has been questioned. Pellets of diethylstilbesterol are implanted by a syringe under the skin of the neck of the bird 4 to 6 weeks before slaughter. Advantages claimed for this procedure include earlier maturing feathers, better over-all finish and palatability, and less fighting among the male birds.

Prefreezing preparation, including methods of killing, bleeding, removing feathers, and eviscerating, may all affect the keeping quality of poultry.
in frozen storage. Modern methods of slaughtering are aimed at killing the birds in such a way that wings are not broken, skin and meat are kept intact, and maximum bleeding is promoted.

The dry-picking method of removing feathers, usually involving piercing of the brain to relax the feather muscles, requires speed and careful timing so that feathers are removed before the muscles contract. A more common method of relaxing feather muscles is the use of a "semiscald," a dip in vigorously agitated water at 126° to 130° F. for about 30 seconds. After such a treatment, the feather muscles are practically permanently relaxed, the feathers are easily removed, and the heat treatment does not damage the skin. Higher temperature or longer scalding times may seriously affect the appearance and keeping qualities of the poultry. Many processors have found that wax dipping, used in conjunction with dry picking or semiscald picking, results in a superior product.

Much of the recent research on maintaining quality in poultry has dealt with the effects of evisceration practices. Off-flavors and off-odors gradually develop in poultry held uneviscerated at temperatures above freezing. The undesirable changes are noticed first in the regions that are in intimate contact with the viscera, and with longer holding they extend to other parts of the bird. Visceral taint is less in birds that are chilled promptly, because a lower temperature lessens the bacterial action and putrefactive changes. In some circumstances, as in certain commercial operations, it is not convenient or practical to eviscerate birds immediately. The supply of local unfrozen poultry is often not enough to maintain a constant eviscerating process; and frozen, dressed birds that can be thawed and eviscerated help to give sufficient volume. The presence of visceral taint in poultry is not exclusively a problem of the frozen-poultry industry. Because of the relatively common practice of freezing uneviscerated birds, however, the prevention of off-flavor development has of necessity interested the producers of frozen poultry.

In view of the eventual development of visceral taint in uneviscerated birds, it became important to learn how long and under what conditions birds could be held uneviscerated without detrimental effect on the flavor of the meat. Research on the problem showed that if birds are chilled rapidly, the length of time they can be held uneviscerated before freezing is related to the holding temperature. The lower the holding temperature, the longer they can be held without development of off-flavors. Experiments with broilers and fryers at the Iowa Agricultural Experiment Station showed that off-flavors develop within 18 to 40 hours in birds chilled promptly and held at approximately 35° F. Longer holding periods increase the degree of off-flavor. Where it is impossible to eviscerate poultry promptly and where a method of fast freezing is available, the desirable flavor of the birds can be preserved more successfully by freezing than by holding them at chill-room temperatures until they can be eviscerated. The birds can then be rapidly thawed and eviscerated later. Rapid thawing and prompt evisceration are, of course, necessary, since deterioration in flavor continues if the thawed birds are held uneviscerated. The shorter the time birds are held uneviscerated at temperatures above freezing, the less will be the visceral off-flavor. All visceral taint can be prevented by prompt (warm) evisceration of poultry immediately after killing and picking. Warm evisceration is strongly recommended and present trends in commercial operations are in that direction.

The possible disadvantages, as well as the advantages, of warm evisceration have been investigated. Increased bacterial contamination and rancidity have received most attention. It is true that bacterial contamination can be increased if evisceration is not properly done. In modern processing plants,
however, adequate sanitary controls can be provided so that this danger should be eliminated.

Evisceration before storage increases the surface exposed in the visceral cavity. This in turn may lead to development of rancidity in the visceral fat under poor conditions of frozen storage. The experiments to date on turkeys and chickens have shown that rancidity is not a major problem under usual conditions of handling. Holding eviscerated turkeys for as long as 30 hours at 35° F. before freezing did not increase the degree of rancidity that could be detected by flavor tests at the Western Regional Research Laboratory after storage at —10° F. for 18 months. Research at the Iowa Agricultural Experiment Station showed that broilers that were eviscerated and chilled promptly were as excellent in flavor after holding 18 hours at 35° F. before freezing as they were when frozen within 2 hours. In experiments with eviscerated and chilled fowls, off-flavors did not develop until after 2 days of holding at refrigerator temperature. Workers at the Kansas Agricultural Experiment Station discovered that the aroma of eviscerated chickens held in frozen storage could be improved by cutting them in pieces and packing compactly in cellophane rather than wrapping them in cellophane without cutting. The better aroma of the cut-up birds was thought to be related to the smaller amount of surface exposed.

Successful frozen storage of poultry depends on the degree to which the original high quality of a freshly killed bird can be preserved.

The loss of juiciness, deterioration in aroma and flavor, and changes in appearance (such as darkening in color and dehydration) are the principal changes during adverse conditions of frozen storage. The extent of such changes and the means of preventing or minimizing them depend on packaging efficiency, storage temperature, and storage time. G. F. Stewart and others found that the actual rate of freezing had little effect on the final quality of the stored bird. No differences were found in the palatability of broilers that were frozen at temperatures from —5° to —90° F., with freezing times ranging from 5 hours to 10 minutes.

Investigations have been made of eviscerated chicken wrapped in moisture- and vapor-resistant cellophane. C. H. Koonz and his coworkers found that to retain high quality in eviscerated cellophane-wrapped poultry for a year it should be held at —10° F. or lower. Under those conditions, the chicken is still palatable, although it loses about 1 percent moisture, and slight darkening and desiccation are noticeable. If the storage period is limited to 9 months, the storage temperature used with the cellophane wrap can be as high as 0° F. A storage temperature of 10° F. is not satisfactory for periods of more than 6 months, and temperatures above 10° F. can be used only for relatively short periods without darkening in color, desiccation, microbiological growth, loss of juiciness, and deterioration in aroma and flavor.

C. W. DuBois and his coworkers found that poultry wrapped only in wax paper loses 10.7 percent moisture when held at 10° F. for 6 months, and 4.7 percent moisture when held at 0° F. for 12 months. Losses in rubber latex and moisture- and vapor-proof cellophane were slight at temperatures of 10° F. to —25° F. for storage as long as a year.

Experiments performed at Iowa State College showed that differences in appearance of poultry packaged in tin containers and in waxed cartons were pronounced at high storage temperatures, but were less as the storage temperature was lowered to 0° F. or below. In order to prevent undue moisture loss and the accompanying loss in quality, it is advisable to package poultry in some type of moisture-vapor resistant material.

Despite all precautions in the matter of efficient packaging material and low temperature, adequate sanitary controls can be provided so that this danger should be eliminated.

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Despite all precautions in the matter of efficient packaging material and low temperature, adequate sanitary controls can be provided so that this danger should be eliminated.
Storage temperature, some changes in quality are unavoidable if the storage time is prolonged. The changes often are slight and can be detected only by experts making direct comparisons with freshly killed birds. For example, differences in juiciness and flavor between frozen and freshly killed poultry can be detected when frozen poultry has been wrapped in moisture-resistant material and stored for as short a period as 2 months at $-10^\circ$ F. The dryness of the cooked meat noted in frozen birds is apparently a storage problem rather than a freezing problem, because it does not appear immediately after freezing. It is progressive as the storage time increases and is more pronounced at higher ($+10^\circ$ F.) than at lower storage temperatures ($-10^\circ$ F.). The loss of juiciness is noted in cases of little or no actual moisture loss, when birds have been properly packaged and do not show weight loss in storage. It is not influenced by thawing and refreezing or by different rates of freezing. It is a change that is noticeable with extended storage, but is probably not so objectionable as to detract from enjoyment of the product.

A more serious change takes place with extended storage of frozen giblets, particularly livers. The deterioration in flavor of frozen liver is so rapid that changes can be detected in less than a month in liver held at $-10^\circ$ F. With such a limited storage life, it would seem more practical to use the liver as a fresh product or process it by other means.

**AMONG THE RECENT DEVELOPMENTS in poultry processing are cut-up poultry and turkey steaks, precooked frozen poultry, canning, and smoking.**

Efforts to increase the consumption of poultry meat depend largely on means of making poultry available in attractive, ready-to-cook, small packages that are enough for one meal for an average family. The increase in frozen-food display cases in retail stores has helped the development of packaged cut-up poultry. The need to make poultry an everyday dish as well as a holiday item is especially pressing for turkeys, which may range from 15 to 30 pounds, live weight. Turkeys have been marketed to a limited extent in the form of halves, quarters, and parts. Packages of 4 to 6 pounds may contain a leg or thigh, a large piece of breast meat, and either a wing or an extra piece of white meat.

F. Z. Beanblossom, poultry marketing specialist at Texas Agricultural and Mechanical College, has developed a way to prepare turkey steaks that weigh 4 to 6 ounces. The raw breast and thigh meat are cut from the bones, and appropriate weights of meat are formed into steaks by means of a cube-steak machine. A 33.5-pound live tom turkey (29.9 pounds dressed, 26 pounds eviscerated) furnishes 8.3 pounds of white meat and 5.6 pounds of dark meat. The wings and giblets may be sold as such; the neck, skin, and carcass have value for soup stock.

Another proposed method of providing turkey in individual steak portions involves cutting the frozen eviscerated carcass into transverse slices with a meat saw.

Cutting poultry into parts presents new problems in packaging and storage; the large increase in cut surface encourages dehydration and rancidification. The Department of Agriculture in 1948 investigated the storage characteristics of the two forms of turkey steaks. Deboned steaks, prepared by the Beanblossom method, and transversely cut steaks, with bones intact, were stored in cellophane, polyethylene film, aluminum foil, and parchment at temperatures of $-30^\circ$, $-10^\circ$, $0^\circ$, and $+10^\circ$ F. The steaks prepared from thigh meat were considerably less stable than those made from breast meat. Even under the best commercial conditions of packaging and frozen storage, turkey steaks should not be stored longer than 3 months. It is better to store the whole eviscerated carcass and cut it into steaks just before retail marketing. Incorporation of rendered turkey fat or
fatty tissue into the deboned steaks resulted in more rapid deterioration.

A large part of commercial broiler production is now sold as fresh or frozen, cut-up chicken.

M. A. Jull and his coworkers at the University of Maryland studied the distribution of weight in the parts of 12-week (2.7 pounds live weight) New Hampshire cockerels and reported the following percentages of the dressed weight: Breast, 17.5; first wing joints, 4.6; and legs, 23.8. The weights of edible meat, as percentages of chilled, dressed weight were: Breast, 14.6; first wing joints, 3.3; and legs, 20.4. Values for the weight of parts, expressed as the percentage of dressed weight, of 22-week-old Rhode Island cockerels were reported by H. M. Harshaw of the Department of Agriculture as follows: Drawn weight, 79.8; breast, 18.4; drum sticks, 12.8; thighs, 14.7; neck, 4.4; wings, 8.1; back, 15.5; and organs, 5.8.

A relatively new development is cooked frozen products, such as chicken à la king. The completely prepared product needs only to be heated to serving temperature before it is ready to eat. The convenience of such items can be readily appreciated; if the quality is good, the demand for them will undoubtedly continue to increase. At their best, these items retain the characteristics of the freshly cooked products as distinguished from canned products that may have a changed flavor or texture because of their more intensive heat treatment.

The production of cooked frozen food is such a recent development that very little research has been done on the best methods of cooking, packaging, freezing, or storage. The studies on cooked frozen meat to date have shown that the meat retains its flavor better when packaged as a solid pack rather than a loose pack. That is, meat surrounded by a sauce or gravy retains its fresh flavor longer than pieces packed loosely and exposed to the air in the package. A chicken à la king or a chicken loaf would, therefore, be expected to retain its flavor better than loosely packed slices of cooked chicken. It is also known that any conditions accelerating the development of rancidity, such as high storage temperatures or long storage periods, would hurt the quality of cooked frozen meat in much the same way as they affect raw frozen meat. The rate at which changes take place in cooked poultry products has not been investigated to any extent.

The microbiological aspects of frozen cooked poultry meat have received attention because of the possible health hazard if they are improperly prepared or inadequately handled. The product is not usually given any treatment that would render it sterile after it is cooked. Freezing and frozen storage only reduce the number of viable organisms, and the product is usually warmed only to serving temperature. In order to keep microbiological contamination and growth to a minimum, it is essential that the cooked meat be prepared under sanitary conditions and that the time elapsing between cooking and freezing be as short as possible. Further precautions must be observed after removal of frozen food from the freezer. In order to prevent growth of organisms that may have survived frozen storage, the thawing period should not be prolonged. Heating of frozen foods directly from the frozen state will cut this period to a minimum.

CANNING AND SMOKING are other methods of preserving poultry. Canning aids the poultry industry in several ways. Besides making precooked poultry products available under all conditions, it also makes use of over-age birds. A number of birds of poor appearance but of good eating quality are also removed from the household market.

Poultry products are commercially canned in a variety of forms—whole, boned, and deviled chicken and turkey; chicken à la king; chicken curry; chicken and noodles; and chicken soups, including broth, consommé, and
Processing times (in minutes) for home-canned poultry

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1 Processing at 10 pounds pressure (240°F).

Jellied, creamed, noodle, and gumbo soups. Chicken meat and broth have a flavoring ability that is well liked by a great many consumers of canned foods. The mild flavor, tenderness, and digestibility of poultry meat and broth have long made it a food recommended for invalids and infants.

Poultry for canning is inspected for soundness, wholesomeness, and fitness for human food by the inspection service of the Department of Agriculture. Examination of the poultry for canning by licensed inspectors within the plants is similar to that for all eviscerated poultry. It eliminates all emaciated and diseased birds. The inspectors are responsible also for the general plant sanitation and for seeing that all substances and ingredients used in the manufacture or preparation of the various edible canned poultry products are clean, sound, wholesome, and fit for human food. No definite standards have been set up for the various poultry products, so that the canner prepares and seasons the products as he sees fit.

The commercial canning of most poultry products is done by first precooking the poultry in an open kettle or under pressure. The meaty pieces are taken from the broth and the larger pieces of skin and bones removed. The skin is ground and returned to the broth. The excess fat can be skimmed from the broth, leaving enough to flavor it and to give richness to the product without too much fat. The boned meat is cut to a suitable size, placed in cans or jars, sealed, and processed in retorts.

A comparison of the open-kettle method (60 to 90 minutes) and pressure cooking (15 to 20 minutes) showed that the meat contained 10 percent less moisture when it was pressure cooked, and the broth had better flavor, with two to three times more solids. Pressure precooking also preserved the better quality of grade A chickens; with the open-kettle method, grade C chicken was inferior to grades B and A, but no differences were observed between the A and B classes. It also has been learned that mature hens and dark meat lost more moisture than chickens and white meat when precooked under pressure. The losses or gains in moisture are important when it comes to putting a definite weight or percentage of meat in the can.

Chickens and turkeys may also be precooked by roasting and placed in the cans whole, halved, or cut up with or without boning. That is a highly specialized process and calls for special methods and sometimes cans of special shapes.

The time and temperature for the commercial processing of the various poultry canned products are given in texts on canning. The home canning of poultry often proves to be a convenient method of preserving a surplus. The Bureau of Human Nutrition and Home Economics has explained the methods in Bulletin AWI-110, The Home Canning of Meat. A timetable for processing precooked packs with or without bones is given above.

The curing and smoking of chickens and turkeys has been a common
method of processing in some areas for many years. The product ranks as a delicacy. Here is a recommended way of smoking turkey: The birds are killed and plucked after slack scalding (126°F for 30 seconds) to prevent injury to the skin. Then they are eviscerated and the heads, feet, and necks removed, so that the pickle brine can pass completely through the body cavity. The curing mixture consists of 6 pounds of salt, 3 pounds of brown sugar, and 2 ounces of saltpeter dissolved in 4½ gallons of water. The drawn turkeys are packed in a suitable container and covered with the curing solution. The turkey should be kept cool (38°F) while it is in the curing solution. The cure should go on for 18 to 25 days, depending on the weight of the bird. The cured turkeys are washed in warm water, hung until dry, and then smoked for several hours. A smokehouse temperature of 135° to 140°F, for 16 hours gives an uncooked product of desirable color. A smokehouse temperature of 220° to 240°F gives a cooked product which may be eaten cold as an appetizer.

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Helen L. Hanson is in charge of the utilization and appraisal section of the poultry products division in the Western Laboratory. Dr. Hanson has degrees from the University of California at Los Angeles and Iowa State College.

Edmund H. McNally, now with the Bureau of Animal Industry at Beltsville, Md., has been engaged in various phases of poultry research in the Department of Agriculture since 1928.

At the Western Regional Research Laboratory samples of fruits and vegetables frozen in tin cans 11 to 19 years earlier were opened recently. During the period they had remained in freezing storage at zero or below. Strawberry and raspberry purees with added sirup had retained their fresh-fruit color, aroma, and flavor exceptionally well. Dry-packed youngberries frozen in 1933 had acquired an off-flavor. Nectarine halves in sugar sirup retained their natural color. The defrosted halves had fresh flavor when eaten raw but a slightly oxidized flavor after they were cooked. Broccoli frozen in 1938 retained an excellent deep-green color and was considered edible. Brussels sprouts frozen the same year had acquired a yellow color in the lighter portions and an off-flavor. Apparently the airtight containers and the low, nonfluctuating storage temperature were responsible for the successful long-term preservation of quality. Air in some of the packs probably accounted for their deterioration.—D. G. Sorber, Western Regional Research Laboratory.