

POULTRY PRODUCTS AS FOOD

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Summary

Poultry products are nutritious and add variety to the human diet. Most of the products are from chickens, but ducks and turkeys also are important sources. In developing countries, rural production systems for maintaining poultry are not far removed from conditions encountered by wild chickens and ducks. Where reliable refrigeration is not available, consumers purchase small amounts of poultry meat and eggs on a regular basis. In developed countries, commercial production systems provide large supplies of meat and eggs. The food processing industry provides meat in the form of whole carcass, cut-up parts, or further processed meat. Eggs are available as whole (shell) eggs or liquid or component parts. By products from food processing are recycled, usually by inclusion in animal feed.

1. Domestication and Development of Breeds

Domesticated birds are an important source of foods for people in many parts of the world. Much of that food is in the form of meat, but eggs also are important to add nutrition and variety to human diets. Chickens now provide more meat and eggs than all other poultry species combined, so that species will receive most of the attention in this chapter; however, additional food is derived from turkeys, ducks and geese (waterfowl), and pheasants and quail (game birds).

Species of birds that were domesticated were present on earth prior to humans. Each species was wild and developed in a part of the world that permitted it to survive and maintain its numbers. (For a more detailed discussion, see Crawford, 1990.) When humans began to grow their food instead of collect it from the wild, some species of wild animals had characteristics that made domestication possible. These animals accompanied humans as civilizations progressed. In some cultures, birds were a source of food. In other cultures, birds were kept as pets, for entertainment or for sacrifice during religious rituals. Similar practices in our time are keeping birds as pets, raising them for exhibition, or using birds in magic shows.

1.1. Chickens

Archaeological evidence indicates that chickens originated in Asia. There are four species of junglefowl from the area that may have contributed to present day chickens. The red junglefowl (*Gallus gallus*) is considered the most likely ancestor. Junglefowl are members of the pheasant family, with a comb and wattles that distinguish them from other pheasants. Red junglefowl are considered the wild-type from which other color mutations have occurred. This species is found in the wild in Pakistan and in adjacent areas of India and China. Males weigh from 800 to 1360 grams (1.75 to 3.00 pounds), but females are only about 60% as large. The number of eggs that a hen lays for incubation is 4 to 8, with an incubation time of 19 to 21 days.

Definite proof of the time and area of domestication is not possible, because the next archaeological discovery may provide different evidence. One early location where chicken bones or pottery items depicting chickens were found associated with human civilization is in the Indus Valley in Pakistan. This association dated back to 2100 to 2500 B.C. More recent archaeological evidence from China suggests domestication may have occurred as early as 5000 to 6000 B.C.

After domestication, chickens were distributed to many parts of the world, probably following trade routes. Pictorial artifacts indicate that chickens were present in Egypt as early as 1840 B.C. There is some evidence that initial introductions of chickens may not have been successfully sustained. Gaps in the historical record suggest the disappearance and the re-establishment of chickens.

The presence of chickens is not documented in Greece until about 500 B.C. For the Greeks, chickens seem to have had little importance. That is in contrast to the Romans, who took them to military outposts throughout the Roman Empire. Chickens apparently were used for food, cock-fighting, and religious practices. Roman writings of the time

recorded advanced husbandry practices to supply all of the chickens that were needed by their culture.

A decline in the importance of chickens accompanied the decline of the Roman Empire. When Europe later emerged from the Middle Ages, chickens again became more important. It is not known if the chickens that became popular were from stock that had survived in Europe or if there was a re-introduction of chickens from Asia. Over a period of several hundred years, cock-fighting became a fashionable sport. Successful owners selected birds to become good fighters and learned a great deal about the care of chickens. But eventually the sport was outlawed, and many breeders turned their attention to developing new breeds of chickens.

It is generally accepted that chickens were brought by the Spanish explorers to the Americas. They were readily accepted by the Native Americans and soon had wide distribution. Some of the cultures did not eat them, using them only for cockfighting and religious practices. In these cultures, chickens were generally not a source of food. In other cultures, chickens were used for food.

The red junglefowl appears to have changed little over thousands of years; however, the intervention of humans has resulted in hundreds of breeds of chickens. These purebreds are described in *American Standard of Perfection* (1998) and *Poultry of the World* (1996). In Asia, the sport of cockfighting developed, in which birds were paired and fought to the death. Big muscular birds fared better in this sport than smaller birds. Winning birds provided the breeding stock, so fighting cocks became bigger over the centuries. Indian games (fighting cocks) were imported into England and were the basis for Old English games, also used for fighting. They, in turn, provided the basic genetic material for the Cornish breed, a chicken with extreme muscling that resulted in a broad breast.

Cornish stock was imported into North America, where they provided genetic material for the meaty broiler chickens. Continued selection for broad breasts has increased the percentage of the body that is white meat, the part of the chicken that is prized most by North Americans. The story of the development of the chicken meat industry shows how chickens have moved from one continent to another and how humans have changed the function of the chicken in the process.

There is a different story for chickens that produce most of the white-shelled eggs. Domesticated chickens were taken from Asia to areas around the Mediterranean Sea. In that area, selection must have been to produce more and larger eggs. Instead of producing 10 or 12 eggs per year, hens that were imported to North America from the Mediterranean area produced dozens of eggs per year. This class of chickens provided the genetic material that was used for egg production breeds. These chickens are somewhat heavier than the junglefowl but not nearly as heavy as chickens that are used for meat production.

An important reason for the large number of chicken breeds is the number of mutations that is known. In the wild, mutants often do not survive or cannot be identified. In captivity, breeding only a small number of closely related chickens resulted in the visual expression of mutations. For example, the red junglefowl has a single comb. Mutants

such as rose, pea, walnut and buttercup comb are known. The male red junglefowl has mostly red or brown feathers to go with its black breast plumage (see Figure 1). The wild type color is due to at least 5 different gene combinations. Mutations in any of these genes can produce variations in color and pattern. Therefore, chickens may be red, black, white, or many combinations of these colors.

Mutations have occurred in the legs, so that chickens have four to six toes, yellow, white or black scales, and clean or feathered legs. Mutations in head parts have produced crests, muffs and tufts. Mutations in feather structure and location have produced naked necks, frizzles and silkies. In addition, for most standard sized chickens, there is a bantam counterpart that weighs about 450 grams (one pound). All of these mutations presented the possibility for different combinations of mutations to form breeds. Poultry fanciers seized the opportunity to make numerous combinations in the nineteenth and early twentieth centuries when many breeds of chickens were developed. An individual or group of individuals combined breeds of chickens to develop a new breed. The new breed was displayed at poultry shows to advertise its presence. When the breed had been improved to the point that it would produce offspring essentially like itself, the breed was registered with the appropriate poultry organization. A number of the breeds that were developed at that time are no longer available, but poultry fanciers continue to breed and show purebreds.



Figure 1. Male red junglefowl

1.2. Turkeys

There is much more certainty about the origin and domestication of the turkey than of the chicken. Turkeys are native to North America. When Europeans arrived in North America, turkeys were present in much of what is now the United States. They were also present in much of Mexico and ranged into parts of Canada. Their habitat was woods interspersed with open fields.

Domesticated turkeys descended from the wild turkey, *Meleagris gallopavo*. There are seven sub-species that had different geographical locations. One of these sub-species (Mexican) had been domesticated by the Native Americans when the Spanish arrived in Mexico. Records indicate that turkeys were introduced in Spain no later than 1511. The first record of turkeys in England is in 1541, so they spread very quickly through the western world.

In North America, domesticated turkeys were brought from Europe during the first half of the 1600s. The eastern wild turkey, one sub-species of *M. gallopavo*, was native to the area and was hunted as a source of food. Although it was not domesticated, the eastern wild turkey was important in the development of the commercial turkey. The domesticated turkey that the Europeans brought to North America was black in appearance and was smaller than the eastern turkey. Wild eastern males took the initiative to mate with domesticated Mexican females and the hybrid vigor of the offspring became obvious (see Figure 2). The offspring had a color pattern similar to the eastern turkey, which was called bronze.



Figure 2. A typical male turkey of stock produced by crossing European turkeys with wild stock from eastern North America

None of these birds, however, had the large amount of breast muscle that we now associate with the turkey. Years of selection for that characteristic resulted in the Broad Breasted Bronze, which generally was the turkey of choice for decades. Eventually, the commercial industry chose a turkey with white feathers, drawing on feather color mutations known when the Spaniards first encountered the turkey in Mexico.

1.3. Ducks

The consensus is that domesticated ducks came from mallards (*Anas platyrhynchos*). These ducks have adapted to a broad range of habitat in the northern hemisphere. There are seven sub-species of mallard, but the most adaptable is the common mallard. In the wild, they were found in Europe and Asia. It is thought that domesticated ducks originated from this sub-species with the colorful male (see Figure 3).



Figure 3. A male mallard

Domestication may have occurred in China as early as 4000 years ago. Art and jewelry from ancient sites depict ducks, indicating close association with humans. It is thought that domestication may have occurred at several times and different places. When a culture prospered, domesticated poultry were more important in peoples' lives. When cultures went into decline, interest in duck production also seemed to decline. If a new culture prospered, domestication of ducks may have occurred once again. There is evidence that an independent domestication of ducks occurred in Europe during medieval times.

A number of breeds of ducks have been developed over the years. Some of them retain the color pattern of the common mallard, but most do not. Size ranges from the call ducks, which are smaller than mallards, to the heavy breeds, which are several times larger than mallards. The breed that is most popular for meat is the White Pekin. It was developed in China and was imported into several countries in the 1840s. Commercial companies are changing this breed to meet the desires of consumers.

Several breeds of ducks are also excellent egg layers. Runners, ducks that have the posture of penguins, may surpass the best chickens for egg production. An egg a day for at least 300 days has been recorded. Other breeds of ducks almost equal Runners for egg production.

2. Production Systems

Poultry production systems are linked to the economy of a region. In some countries, as many as 75% of the people are engaged in agriculture. Rural production systems are used in these countries. At the other extreme are countries in which only about 2% of the people are engaged in agriculture. Large commercial systems are standard in these countries.

2.1. Rural Production Systems

There are several variations of the rural production system. One is the traditional free range system (see Figure 4). Chickens in groups of 15 or less are free to roam through the village or countryside. They feed on insects, food waste, crop residue, weeds or any food source that they can find. Local chickens are used in this free range system, because only they can survive. Characteristics that are important are possession of maternal ability, adaptability to harsh living conditions, and resistance to specific diseases. No housing is provided, so the chickens must know how to avoid predators by finding safe roosting spots at night. They are also susceptible to parasitic infestations such as red mites. No veterinary care is available, so the chicken's immune system must be able to overcome any disease challenge. The appearance of a disease such as Newcastle disease, a viral disease that affects the respiratory system, may wipe out chickens in a whole village or region. In this system, chickens receive no help from humans to increase their productivity. Women, sometimes helped by children, gather the eggs and save them until market day. They are then sold in a nearby town in small quantities.



Figure 4. Traditional free range system for raising chickens

Another variation of the rural poultry system is often used. In the family backyard poultry system (semi-intensive), conditions are similar to those discussed above. One difference is that chickens are provided a shelter at night that helps protect them from predators (see Figure 5). Water is normally provided, and sometimes the chickens

receive additional grain. Because chickens are susceptible to contagious and nutritional diseases, the rate of survival and productivity is not high. The number of birds in this system does not usually exceed 30. Chickens are from local stock or may be crosses of local stock and improved commercial stocks.



Figure 5. Chickens in the family backyard poultry system

The family backyard poultry system suggests some economic prosperity. Those who follow this system own property and can afford to build a chicken shelter. The poorest in society, the landless laborers, own no property and do not have the resources to keep poultry. A third type of rural system is the small-scale intensive system. Chickens in this system are provided proper housing, feed and veterinary care. They can be kept in cages or in houses with bedding material on the floor. Birds with high productivity are usually imported for this system. Flock sizes range between 50 and 500 birds.

It has been estimated that these rural systems account for as much as 75% of the poultry in developing countries. Poultry supply some of the meat and eggs for the human population and in this way may provide cash earnings to rural women. Poultry may also be given as gifts or offered as sacrifice in religious worship.

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Biographical Sketches

J. D. Latshaw is a professor in the Department of Animal Sciences at The Ohio State University in Columbus, Ohio. He teaches the introductory animal nutrition course in the department. His other major teaching responsibility is the introductory course in poultry science. His research has focused on nutrition of the chicken. At the present time, the objective is to relate nutrition to the normal or abnormal development of the growth plate in bones. He is currently co-editor of the nutrition section of the journal Poultry Science.

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