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# Normal Birds - A Review of Avian Anatomy

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INSIDE



A necropsy is the examination of a bird externally and internally to determine the cause of death. The method for doing a necropsy varies and depends somewhat on the bird involved, the preference of the individual performing the necropsy, the disease(s) suspected, and where the necropsy is being done. Regardless of the method; the most important point to remember is to systematically evaluate each organ and organ system for changes associated with disease. Since only a few diseases cause very specific lesions in the organs; it is very important to be "familiar" with the normal external and internal anatomy. Usually a necropsy starts with a detailed examination of the external anatomy of the bird.

## External Anatomy

### Feathers and Skin

Feathers cover the majority of the skin and are arranged in feather tracts rather than randomly distributed. The feathers should be clean at the point of attachment to the skin and the edges of the feathers should be smooth with no clear areas present in the barbs.

The skin of a chicken and/or turkey is thin and semi-transparent over most of the body. The muscles, veins, and fat deposits can be observed through the skin in most birds. The muscles appear as dark areas; whereas, fat is yellow. The skin on the face and bottom of the foot is thickened and is normally white or yellow in color. The comb, wattles, and car lobes are usually bright red in color in commercial layers and broiler breeders. It is normal for market and breeder turkeys to develop red or bluish skin on the head and neck. Normal commercial layers and breeder hens may have a reddish yellow skin on the comb, ear lobe, or other facial structures (this is especially true if they are beginning to come into production or are out of production).

The lower legs are covered with scales which are yellow to white in coloration. The thickened skin on the bottom of the foot (footpad) is usually a pale yellow-tan or yellow-white color (the scales of the leg arc similarly colored). Chicks and poults have yellow colored leg scales. Adult broilers and commercial layers can have yellow or white leg scales. Turkey leg scales are white to light tan colored. The leg coloration will change in hens from yellow to white and vice versa as they go into or out of egg production.

The skin, leg, and feather coloration of many of the varieties of chickens, ducks, and turkeys kept as backyard, hobby, pet, or exhibition flocks may vary from those listed. The best source for individual breed differences is the book " The American Standard of Perfection," which is published by the American Poultry Association or the "American Bantam Standard."

### Ears, Eyes, Nostrils and Beak

The ear in a bird is covered with fine feathers and is a small opening located on the side of the head. The eye should be a bright

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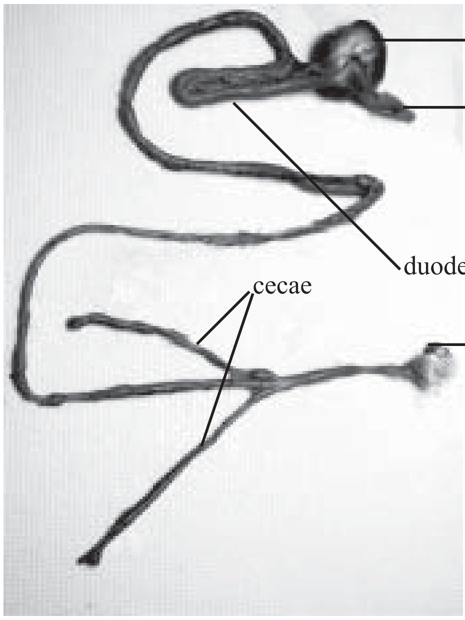
*. . . helping ensure the efficient production of top quality poultry products in Arkansas and beyond.*

yellow-orange in color and free of discharges. The eyes should be clear with dark black pupils surrounded by a colored iris. The color of the iris varies with the breed and age of the bird, but in general is steel-grey in chicks and poults. In adult broilers, layers, and broiler breeders the iris is yellow-orange; but brown in adult turkeys. The nostrils are slit like openings on top of the beak and at the base of the beak. They are surrounded by tan-yellow fleshy skin called the cere. The beak is a yellow-horn to white-horn color in the normal bird and has a smooth surface with the end of the beak pointed or blunted in a beak-trimmed bird. Again, colors other than those listed may be normal for many of the varieties of chickens, ducks, and turkeys kept as backyard, hobby, pet, or exhibition flocks. As before, the best source for these breed differences is the " The American Standard of Perfection" or the "American Bantam Standard" book.

## Internal Anatomy

Once the external anatomy has been evaluated the internal anatomy of the bird is examined. The skin should be removed and the bird opened to expose internal organs. The procedure of initially opening the bird to evaluate the internal organs may vary depending on the personal preference of the individual performing the necropsy. However, regardless of the procedure, it is important to evaluate all organs present systematically and thoroughly.

The first organs that come into view when the skin of a chicken or turkey is removed for necropsy are the muscles, sternal bursa, and bone (keel). The breast muscles are a grey-white in color normal poultry. The point of the keel is white and the edge of the bone is straight. The sternal bursa is a white sac-like structure that is located on the sternum and contains a small amount of clear fluid. If the leg muscles are observed they are a darker grey-white color and the sciatic nerve (located between the leg muscles) is a glistening white with cross striations.




**Thoracic (Chest) and Abdominal Anatomy**

After the sternum and breast muscles are removed the internal organs are evaluated, The heart is a triangular shaped organ (the base of which is toward the head of the bird) that is surrounded by a clear sac (pericardial sac). The heart is grey-white in color and has a band of yellow fat near the base. Internally, the heart is the same color with clear membranous valves between heart chambers. The left ventricle (lower left chamber) of the heart is thicker than the right ventricle. The heart is almost completely surrounded by the lobes of the liver.

The liver is the largest internal organ, is firm, and has prominent sharply defined edges. The color of the liver varies with diet. Baby chicks and poults tend to have a liver that is yellow in color due to yolk absorption. Adult birds can have a yellow-tan liver if on a high fat diet and the organ may be soft. The adult bird usually has a dark red to red brown colored liver.

The avian gallbladder is attached to the liver lobe and can be easily examined by moving the liver to one side. This sack-like structure is greenish-black in color due to the bile present in it.

The trachea and syrinx (voice box) are visible at the base of the heart. These structures are white with the trachea a round tube like structure that divides into smaller left and right bronchi. The syrinx is a flattened area of the trachea that is at the end of the trachea before it dividing into bronchi. The bronchi are identical to the trachea in color and shape but are of a smaller diameter. However, a better examination of the trachea is done in the neck of the bird. The aorta is also visible at the base of the heart and is the artery that connects to the heart's left ventricle. This tubular structure is thick walled and pink white to red-white in color. The aorta and smaller connecting arteries are better examined after the organs in the thorax and abdomen are removed. The fat pad that covers the organs must be cut or torn to reveal the gizzard (ventriculus) and the stomach (proventriculus) to the bird's right side. The spleen is readily visible at the junction of the stomach and gizzard after they are exposed. This lymphoid organ is oval or elliptical in shape and dark red to purple in coloration. The spleen in an adult bird is approximately one inch long.

The air sacs on the left are also readily visible after the stomach and gizzard are set aside. These clear membranes are attached to the lungs and increase the respiratory capacity of the bird. Female birds that are in production may have yellow fat deposits on the air sacs. The air sacs on the bird's right side should also be examined; it is usually necessary to move the liver, stomach, and gizzard to the bird's left side to examine them adequately.

Avian lungs are closely adhered to the ribs and are an orange-red or pink-red color. The lungs can be removed for a close examination of the ribs. The ribs, as with all avian bones, are smooth thin walled and white. Immediately below the lungs are the kidneys, adrenal glands, and gonadal tissues (testes or orvaries). The kidneys are firmly embedded in depressions in the bone (synsacrum) and have three distinct lobes (cranial, middle, and caudal). The bird has two kidneys, a left and right, and these organs are dark red to dark brown with a fine reticulated patient visible. A small, white tube (the ureter) connects each kidney to the cloaca. The adrenal glands are small tan triangular shaped glands located at the section of the kidney near the lung. Gonadal tissue is also located near the kidney. The male has two testes, one on either side of the midline. These organs are bean shaped or elliptical shaped and tan. Two small white coiled tubules connect the testes to the cloaca. In the female only the left ovary and oviduct are generally present near the left kidney. In an immature female the ovary is roughly triangular in shape or shaped like an inverted L. It is white to light yellow in color and may have a granular or gritty appearing surface. The developed oviduct is a large grey-white tubular organ that has distinct longitudinal structures. The oviduct connects the ovary to the cloaca and adds egg components such as albumen, shell membranes and shells as it transports the follicle (yolk) to the surface.

Located near these organs and near the midline is the descending aorta. This thick walled artery is a continuation of the aorta as it leaves the heart. It is from this major artery that numerous smaller arteries arise to supply blood to the internal organs. The aorta is pink-white to red-white in color.

The digestive tract should be examined next. The stomach (proventriculus) is a spindle shaped organ that has the gizzard (ventriculus) attached to it. The stomach is grey in color and internally the lining in glistening grey-white with small papillae (gland openings) present. The gizzard is a round dark brown to dark red organ attached to the gizzard. Internally, the gizzard (ventriculus) has a koilin lining which is yellow to yellow-green in color.

The duodenum is the first section of the small intestines. It is loop shaped and surrounds the pancreas. The pancreas is a white-tan fleshy organ. The duodenum, like all of the small intestines is a tan-grey to white-grey tube which has a fine textured lining similar to the surface of a towel. The jejunum and ilium are the next two sections of the small intestines. Two sack-like structures are attached to the small intestines at the junction of the large intestines and ileum. These structures are the cecae which are thin walled with small thick areas in the wall (cecal tonsils) at the points of attachment to the small intestines. Cecal contents are dark green or dark brown. The large intestine (which is very short) lies between the ileum to the opening to the surface called the cloaca. The cloaca is similar in color to the small intestines but is of larger diameter. Feces in the large intestine and cloaca is generally drier and green to brown feces in color. The ileum contains a more liquid feces of similar color. White pasty urates are often present in the cloaca. The bursa of Fabricius is a round tan-white lymphoid organ which is organ located behind (dorsal) the cloaca.

Most blood vessels are examined along with the organs such as checking the large vessels coming to or leaving the heart when the base of the heart and syrinx are examined. Blood vessels vary in size depending on the organ supplied. Arteries are thicker walled than veins, and are a pink white to red white in color. Veins are thin walled, tend to flatten out when touched and are a dark blue in color due to the blood in them.

**Neck Region**

The mouth and neck of the bird should also be examined. A cut is made at the corner of the mouth and extended down the neck, thus exposing the structures for closer examination. In the mouth of the bird the tongue can be examined. This triangular shaped organ is dull grey-white and has a few bumps (papillae) on the surface. Directly behind the back of the tongue (and connected to it) is the glottis. The glottis is the opening of the trachea. It is white in color and has two folds (left and right) which come together to close the opening when the bird swallows. The oropharynx is the region at the back of the mouth and is a glistening grey-white color. Located on the roof of the mouth is the cleft opening called the choana. This structure should be clean with a small amount of clear mucous usually present in the cleft. The choana is also grey-white in color and numerous conical papillae are around the cleft.

The esophagus should be opening and examined. It too is

grey-white in color and has a smooth surface. There is an organ at the base of the esophagus called the crop. The crop is a pouch of the esophagus and as such is the color and texture of the esophagus. The trachea is also present in the neck. This white tubular structure has rings of cartilage visible from the outside. Inside the trachea is a small amount of clear mucous and the lining is a glistening clear white.

The remaining most obvious organ in the neck is the thymus. This organ is multi-lobed and tan in color. Often yellow fat is intermixed with the lobes. This organ 15 located near the base of the neck and crop.

The beak should be removed to expose the nasal cavity. There are scroll like structures in the nasal cavity which are a tan-white in color. There is also a small amount of clear mucous on these scrolls.

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Another area to examine is the breast musculature. The superficial breast muscle should be cut into to check the deep breast muscle (supracoracoideus muscle). This deep muscle is the same color as the superficial breast muscle.

The joints of the leg are also cut into and examined. All joints in the leg should contain a clear fluid. The cartilage in the leg joints can also be examined at this time. Cartilage is a bright white to grey- white in color and has a smooth surface. The ends of the leg bones are usually cut to examine the bone marrow, and check for cartilage plugs. If a cartilage plug is present in the end of the tibiotarsal bone it appears as a triangular shaped plug that is white to grey-white in color. Bone marrow is red in color and soft in texture.

The structures and organs discussed are those examined on a routine field necropsy. Naturally, any area that looks "abnormal" is more closely examined.

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# Windbreaks for Arkansas Poultry Farms

## Introduction

*Windbreaks are barriers that have been used for centuries to reduce and redirect wind.*

Windbreaks are barriers that have been used for centuries to reduce and redirect wind. They were first used in the mid-1400's when the Scottish Parliament urged the planting of tree belts to protect agricultural production (Droze, 1977). Windbreaks are common in regions like the Western, North Central, and Great Plains of the United States where there is minimal forest cover, strong winds, large amounts of snow, and extreme temperature fluctuations. However, since windbreaks have also been used for privacy screens, dust control, odor control and noise reduction, the Arkansas poultry industry should give them serious consideration. The ever-increasing non-farm population influx into rural, poultry producing areas of the state is adding to the number of complaints and lawsuits between non-farm and farm segments of the population. Windbreaks have the potential to address some of these problems and could improve property values. In addition, planting trees and shrubs is seen as environmentally friendly; therefore, windbreaks around poultry houses could further demonstrate a producer's commitment to a safe, healthy environment now and in the future.

### Windbreak Benefits

Well-designed windbreaks can cut energy costs of a typical farm or ranch home as much as 20 to 40 percent (Wight et al., 1991). Individual savings depend on the local site, climate conditions, and building construction quality, as well as the design and construction of the windbreak. Since windbreaks reduce the force of the wind blowing against the buildings and, in turn, the amount of cold air entering the building, unprotected poultry houses, with poorly fitting doors, numerous cracks or gaps and poor-quality curtains could probably benefit greatly from a well-designed windbreak. A moderately dense windbreak will reduce a 20 mph wind to approximately 5 mph out to a distance of five times the effective height of the windbreak. Table 1 lists wind reductions at various distances upwind and downwind of windbreaks.

**Table 1. Wind speed reductions at various distances windward and leeward of windbreaks with different densities in Midwestern United States [1,2]**

| Type of windbreak | Optical density | Percent of open wind speed at various distances | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Windward (Upwind) | | | Leeward (Downwind) | | | | | |
| | | -25H | -3H | -1H | 5H | 10H | 15H | 20H | 25H | 30H |
| Single row deciduous | 25-30 | 100 | 97 | 85 | 50 | 65 | 80 | 85 | 95 | 100 |
| Single row conifer | 40-60 | 100 | 96 | 84 | 30 | 50 | 60 | 75 | 85 | 95 |
| Multi-row conifer | 60-80 | 100 | 91 | 75 | 25 | 35 | 65 | 85 | 90 | 95 |
| Solid wall | 100 | 100 | 95 | 70 | 25 | 70 | 90 | 95 | 100 | 100 |

[1]Reductions are expressed as percent of open wind speed where open wind speed is assumed to be less than 10 meters per second and distance from windbreak is exressed in terms of windbreak height. (H).

[2]Adapted from Brandle et al. (2004).

Many poultry producers also raise beef cattle. When windbreaks are used to protect cattle fed in open pastures or lots mortality is reduced, feed efficiency is improved and weight losses are reduced by as much as 50 percent. Studies in Iowa over a five year period showed that sheltered cattle gained an average of 80 pounds more per year and on average consumed 129 pounds less feed per hundredweight of gain than those not sheltered (Slusher and Wallace, 1997).

Farmstead windbreaks can also screen undesirable sights, sounds, smells and dust and thus improve living conditions for neighbors, particularly on the downwind side. The plants within the windbreak will absorb some odors while others may be masked by the more desirable smells of aromatic leaves or flowering shrubs that may make up the windbreak. Windbreaks can also reduce noise by deflecting sound off branches and tree trunks or by absorbing sound with leaves, needles, twigs, and smaller branches. For poultry producers this could mean a reduction in noise from tunnel ventilation fans that may, during summer, run 24 hours a day for weeks. In addition, to some degree, undesirable noises may be masked by the more desirable sounds of singing birds attracted by the windbreak and the rustling of leaves. For maximum effectiveness, tree and shrub belts should be tall, dense and located closer to the noise source than to the area protected (Slusher and Wallace, 1997). Poultry farms are a common sight along many roadways in western Arkansas. Screening these with windbreaks would remove them from the public's eye while also beautifying your farming operation and displaying your concern for the environment.

In temperate regions windbreaks can be a major component of successful agricultural systems. However, to be successful, windbreak integration requires a thorough understanding of the agricultural system involved, a basic understanding of how windbreaks work and a working knowledge local conditions.

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**Height, Length and Structure of Windbreaks**

Windbreak height is the most important factor determining the distance downwind protected by a windbreak. For maximum efficiency, the uninterrupted length of the windbreak should be at least 10 times its height (Brandle et al., 2002). Windbreaks usually require at least two kinds of trees with different growth characteristics to provide foliage density at various heights over a period of years (Slusher and Wallace, 1997). Table 2 lists trees and shrubs that have been used in Missouri windbreaks; many of these same species would work well in Arkansas windbreaks as well. Conifer species, such as cedar and pine, and shrubs with multiple stems tend to provide better year-round density, while taller hardwood species, such as ash, oak, or hackberry, generally are used to provide greater height.

**Table 2. Trees and shrubs used in Missouri windbreaks[1]**

| Species | Soil Tolerences | Est. Height (feet) after 20 years | Species | Soil Tolerances | Est. Height (feet) after 20 years |
|---|---|---|---|---|---|
| American holly | 1,2 | <26 | Hackberry | all | 16-25 |
| American plum | all | 15 | Highbush cranberry | 1,3 | <10 |
| American sycamore | all | 26-35 | Kentucky coffee tree | all | 16-25 |
| Amur maple | 1,2 | <16 | Loblolly pine | 1,3 | 26-35 |
| Amur privet | all | 10 | Ninebark | 1,3 | <8 |
| Arborvitae (hardy strain) | 1,3 | 15-20 | Nothern red oak | 1 | 26-35 |
| Autumn olive | 1,2 | <16 | Norway spruce | all | 26-35 |
| Bald cypress | 1,3 | 16-25 | Osage orange | all | 16-26 |
| Basswood | 1 | 26 | Pecan | 1,3 | 26-35 |
| Black Cherry | 1 | 16-25 | Persimmon | all | <26 |
| Blackhaw | 1,2 | <16 | Pin oak | 1,3 | 26-35 |
| Black locust | 1,2 | 26-35 | Redbud | 1,2 | <16 |
| Black walnut | 1 | 26-35 | Red maple | all | >35 |
| Black willow | 1,3 | 25 | Red mulberry | all | <26 |
| Bur oak | all | 16-25 | River birch | 1,3 | 26-35 |
| Catalpa | 1 | 26-35 | Sassafras | 1 | >26 |
| Chinese elm | 1,2 | 26-35 | Shagbark hickory | 1,2 | >16 |
| Chinkapin oak | 1,2 | 16-25 | Shingle oak | all | 26-35 |
| Common lilac | all | <16 | Shortleaf pine | 1,2 | 26-35 |
| Cutleaf staghorn sumac | 1,2 | <8 | Silky dogwood | all | <8 |
| Deciduous holly | 3 | <16 | Silver maple | 1,3 | >35 |
| Eastern cottonwood | all | >35 | Smooth sumac | all | <8 |
| Eastern redcedar | all | 16-25 | Spirea | all | >8 |
| Eastern white pine | 1 | 26-35 | Sweetgum | 1,3 | 26-35 |
| European alder | 1,3 | 26 | Thornless honeylocust | all | 26-35 |
| Flowering dogwood | 1,2 | <26 | White oak | 1,2 | 16-25 |
| Forsythia | all | <16 | Wild plum | all | 15-18 |
| Green ash | all | 26-35 | Yellow poplar | 1 | >35 |

**Key: Soil tolerances**
**1= deep or moderately deep, well-drained or moderately well-drained soils**
**2= shallow, dry soils**
**3= poorly to very poorly drained wet sites**
**All= all of the above sites**

**Symbol for heights < = less than; > = more than**
**[1] Adapted from Slusher and Wallace (1997).**

The amount of wind speed reduction that occurs is determined by the structure of the trees involved. As wind flows through a windbreak, the trunk, branches and leaves absorb some of the momentum of the wind and the roughness of the tree surfaces further slows wind speed. However, density should be adjusted to meet particular objectives. In general, windbreaks with higher densities (multiple rows) are used to protect wildlife, farmsteads, or homesites, while windbreaks with lower densities are used to protect crop fields. Windbreak density is the ratio of the solid portion of the windbreak to the total area of the windbreak. A windbreak density of 40 to 60 percent provides maximum downwind protection in addition to providing tremendous soil erosion control (Brandle et al., 2002).

The prevailing winds in winter are from the north and northwest in Arkansas, so protective windbreaks should be located along the north and west sides of your farmstead. However, windbreaks used for visual screening and dust, odor and noise control near tunnel fans can be placed where needed with proper planning. Windbreaks with both deciduous and evergreen species must have adequate space. If evergreen and deciduous trees are planted as close as 6 to 8 feet apart, the deciduous trees will soon overshadow the evergreens. When this happens, the growth of the evergreens will be stunted, their form will be ruined and their effectiveness greatly reduced. There must be at least 15 to 20 feet of space between rows of evergreen and deciduous species (Slusher and Wallace, 1997).

**Considerations and Tree Spacing**

Slusher and Wallace (1997) suggest keeping the following considerations in mind as you plan your windbreak;

Locate the windbreak where it will be most effective.
Design the windbreak to fit the available space and to meet the purpose of the planting. Design must allow for proper spacing (see below) for tree growth and for use of maintenance equipment.
Select tree and shrub species that are well adapted to your soil and climate conditions. Order trees early.
Properly prepare the planting sight and fence areas accessible to livestock.
Arrange for necessary planting labor and equipment.
Provide care and protection for young seedlings.
Provide proper management practices after windbreak establishment.

When planning the spacing of trees the probable size of the crowns after the trees reach 20 to 30 years of age should be considered. Although a wider spacing means that it will take longer for trees to form an effective wind barrier, the delay in windbreak effectiveness will be more than offset by the increased tree growth rate. In addition, trees that have adequate growing space will live longer, retain their lower limbs better and produce more foliage. Furthermore, the reduced windbreak effectiveness produced by wider spacing can be overcome by staggering the trees in adjacent rows. Rows should be spaced from 15 to 30 feet from each other, depending on the types of trees or shrubs in the adjacent row. Slusher and Wallace (1997) recommend the following spacing for various trees and shrubs:

Space 10 to 12 feet between shrub rows.
Space 15 to 20 feet between shrub and tree rows.
Space 15 to 20 feet between medium and tall tree rows.
Space 20 feet between tall evergreen rows.
Space a minimum of 20 feet between tall evergreen and tall deciduous tree rows.

Remember that spacing must allow for proper use of suitable maintenance equipment. Between trees in a row:

Allow 4 to 6 feet for deciduous shrubs.
Allow 10 to 16 feet between medium-sized evergreens.
Allow 12 to 20 feet between deciduous trees.
Allow 10 to 16 feet between tall evergreen trees.

**Summary**

Winds of change are sweeping across the American agricultural landscape. The general public is no longer as tolerant of agricultural practices as they once were. In addition, agricultural producers are a small minority of the population and must therefore utilize strategies that allow production to increase, while at the same time, living in harmony with their neighbors and, in turn, minimizing complaints or lawsuits from the non-farm population. One such strategy for Arkansas poultry producers is the use of windbreaks. Windbreaks are an old technology used to reduce wind speed but they also have the potential to visually screen poultry houses from public view, disperse odors, dust and noise before these pollutants have a chance to affect the

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neighbors. Also, in today's environmentally conscious society, planting trees is "good" thing to do and may reflect positively on agricultural producers who otherwise might be viewed unfavorably by much of the non-farm population. Be aware that constructing a successful windbreak is no small undertaking so do your homework before grabbing your shovel. Contact your local Extension office, Arkansas Forestry Commission, NRCS office, or local landscape nursery for assistance with planning and constructing a windbreak that will meet the needs of your particular farming operation.

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# Is Mold Growth Hurting Your Performance?

*When molds grow in feeds, they use up nutrients and vitamins that the birds should be getting.*

## Introduction

Unexplainable poor performance can occur from time to time. While production problems can originate from innumerable sources, some common situations should not be overlooked. When management factors are good and birds still perform poorly, it may be time to take a closer look at the feed bins and pans to determine if mold growth is the source of the problem.

## What Can Happen

Over 20 years ago a survey was conducted with five North Carolina broiler companies. Six broiler farms were selected from each company for a total of thirty farms. Farms that participated in the study were chosen based on the productivity indicated by the previous year's records. Two farms from each company were classified as above average in productivity, two were average in productivity and two classified as poor. Schedules were arranged so that chicks arrived at each farm within a few days of each other and were caught at the end of the flock within a few days of each other. One flock was surveyed and feed samples were collected weekly from the feeder pans on each farm. Table 1 contains data collected from this study.

**Table 1. Molds, Aflatoxin and Broiler Production**

| Productivity Classification | No. of farms | Age (Days) | Wt. (lbs.) | Feed Conv | Mold (Count/g) | Aflatoxin (ppb) |
|---|---|---|---|---|---|---|
| Above Average | 10 | 52.6 | 3.88 | 2.13 | 8,000 | 6.13 |
| Average | 10 | 51.9 | 3.83 | 2.15 | 35,000 | 6.49 |
| Below Average | 10 | 52.8 | 3.79 | 2.16 | 43,000 | 13.99 |

From Jones et al. 1982.

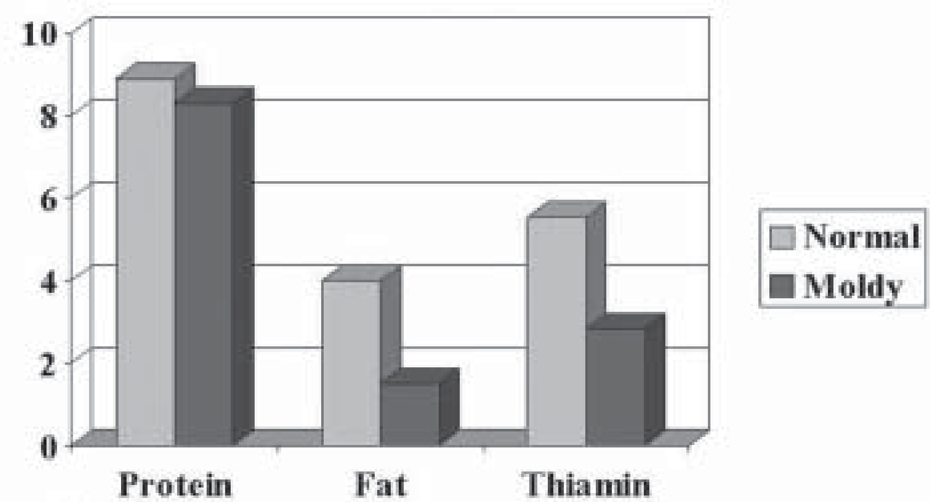
It should be obvious from the weights and feed conversions in Table 1 that these data are over 20 years old! However, please note that as farm productivity gets progressively poorer, weights are lighter and feed conversion worsens. While we all realize that there are many factors that affect performance, these data suggest that molds and aflatoxin are related to performance.

Since farms in the study were on the same placement and catch schedule, they likely got feed at about the same time. Consequently, it seems logical to assume that when feeds arrived on each farm, they contained about the same number of molds. Yet, mold counts from farms with below average productivity are seven times higher than those from farms that were above average in productivity.

**What Happens When Molds Grow in Feeds**

Molds can grow on almost anything. As they grow, nutrients are destroyed and toxin are released. When molds grow in feeds they use up nutrients and vitamins that the birds should be getting. The data in Figure 1 illustrate how mold growth can destroy protein, fats and thiamin in grain. Molds can produce toxic substances call mycotoxins (such as aflatoxin). There are over 250 known mycotoxins produced by many different mold strains. When birds are exposed to high levels of mycotoxins they can cause gut irritation or digestive system problems, skeletal or leg problems, nervous system symptoms and impaired immunity. However, in most field cases birds are exposed to low levels of mycotoxins, which produce non-descript symptoms. Birds may just not seem right, but show no major signs.

**Figure 1. Mold Destruction of Protein, Fats and Thiamin in Grain**




From: Tisdall, 1983

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**How can mold growth happen in feeds?**

Molds can be found virtually anywhere in the natural environment. It is common for pelleted feeds to contain hundreds of mold spores per gram. Molds will grow whenever conditions are right for their growth. The lack of moisture is most often what prevents molds from growing in feeds. While the overall conditions in the feed handling system and poultry house may not promote mold growth, molds will tend to grow in very small areas where conditions are right for growth.

A general depiction of mold metabolism can be seen in Figure 2. It is not necessary to thoroughly understand mold metabolism. However, it is important to realize that as molds grow they produce their own moisture. This metabolic moisture means that the process of mold growth can feed on itself and get faster as it gets going. This moisture also means that the higher the mold count the greater the potential for mold growth.

Figure 2. Mold Metabolism

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

**How to Control Mold Growth**

There are three primary factors that control mold growth. These factors are related to each other and each must be addressed. Control of mold growth in feeds can be accomplished by keeping moisture low, maintaining feed fresh, and keeping equipment clean.

**Moisture Control**

Moisture is the single most important factor in determining if and how rapidly molds will grow in feeds. Moisture in feeds comes from the environment in which the feed is stored or handled. To control mold growth, begin by controlling the obvious sources of moisture in the feed handling and storage equipment. These sources may include leaks in feed storage tanks, augers, and roofs. However, it is important to realize that feed moisture changes in relation to the environment. Since birds add moisture to their environment by respiration and defecation, the air in houses can be very humid. Feed that was initially very low in moisture content will gain moisture when placed in a humid environment. This means that it is crucial to provide adequate ventilation for control of humidity in the house.

**Keeping Feed Fresh**

Time is required for both mold growth and mycotoxin production to occur. It is therefore important to have feeds delivered often so that it will be fresh as possible when consumed. Feeds should generally be consumed within 10 days of delivery. It is equally important to manage the feed delivery system to ensure that feeds are uniform in freshness. Field surveys have shown that poultry farms producing birds with the poorest performance were those with the most feed in their feeder pans. On these farms, the feeds contained the greatest amount of moisture and had the highest number of molds. If the feeder system is allowed to keep the feed pans full at all times, the feed in the pans will be significantly older than that in the storage tank. Birds will tend to eat primarily the feed in the top layer. The feed at the bottom of the pans will age, providing greater opportunities for molds to grow and may hurt performance. To prevent this problem, the feeder system should be turned off weekly. The birds will then be forced to clean up all of the feed in the feeders before it becomes excessively old. A similar principle applies to feed storage tanks. The feed next to the wall is last to exit the tank and therefore stays in the tank the longest. The feed in contact with the wall is also the only portion of the feed that changes appreciably in temperature. These factors make feed in contact with the wall susceptible to moisture migration and mold growth. It is best to completely empty and clean one tank when the new delivery is in the other tank.

**Equipment Cleanliness**

If feed is delivered to farms where old feed is lodged or caked in the feed storage or delivery systems, this old feed is often very moldy and may “seed” the fresher feed it contacts, increasing the chances of mold growth and mycotoxin formation. To address this problem, caked, moldy feed should be scraped or brushed off and leaky spots should be sealed. When bins are extremely caked with feed, it may be necessary to sand blast the bin. Feeder pans should be disassembled and areas that contain caked moldy feed should be brushed to bare metal or plastic. It is important to remember to avoid the use of water in cleaning since moisture encourages mold growth.

**Summary**

Molds are present everywhere in nature and grow readily in feeds if conditions are right. When molds grow on feeds they destroy nutrients that are meant for our birds and they may produce mycotoxins that also hurt performance. To control mold growth in feeds, protect feeds from moisture, ensure that feeds are fresh and keep equipment clean.

**References**

Jones, F. T., W. M. Hagler and P. B. Hamilton. 1982. Association of low levels of aflatoxin in feed with productivity losses in commercial broiler operations. Poultry Science 61:861-868.

Tindall, W. 1983. Molds and feeding livestock. Animal Nutrition and Health, July-August, p 5.

## Coming Events:

International Poultry Exposition, January 26-28, 2005, Georgia World Congress Center, Atlanta, GA, U. S. Poultry and Egg Association (770) 493-9401

International Poultry Short Course, February 21-25, 2005. University of Arkansas, Fayetteville, AR, Dr. Frank Jones (479) 575-5443

Poultry Symposium, April 25-27, 2005, Springdale, AR, The Poultry Federation (501) 375-8131

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# UA Poultry Science Extension Specialists

**Dr. R. Keith Bramwell**, Extension Reproductive Physiologist, attended Brigham Young University where he received his B.S. in Animal Science in 1989. He then attended the University of Georgia from 1989 to 1995 where he received both his M.S. and Ph.D. in Poultry Science. As part of his graduate program, he developed the sperm penetration assay, which is still in use today, as both a research tool and as a practical troubleshooting instrument for the poultry industry. He then spent one year studying in the Animal Reproduction and Biotechnology Lab at Colorado State University. In 1996, Bramwell returned to the University of Georgia as an Assistant Professor and Extension Poultry Scientist. Dr. Bramwell joined the Center of Excellence for Poultry Science at the University of Arkansas as an Extension Poultry Specialist in the fall of 2000. His main areas of research and study are regarding the many factors (both management and physiological) that influence fertility and embryonic mortality in broiler breeders. Telephone: 479-575-7036, FAX: 479-575-8775, E-mail: bramwell@uark.edu

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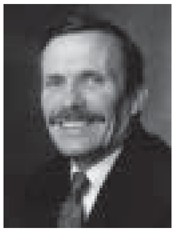

**Dr. Frank Jones**, Extension Section Leader, received his B.S. from the University of Florida and earned his M.S. and Ph.D. degrees from the University of Kentucky. Following completion of his degrees Dr. Jones developed a feed quality assurance extension program which assisted poultry companies with the economical production of high quality feeds at North Carolina State University. His research interests include pre-harvest food safety, poultry feed production, prevention of mycotoxin contamination in poultry feeds and the efficient processing and cooling of commercial eggs. Dr. Jones joined the Center of Excellence in Poultry Science as Extension Section Leader in 1997. Telephone: 479-575-5443, FAX: 479-575-8775, E-mail: ftjones@uark.edu

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