Fall 2005 • Volume 7 no. 3

AVIAN Advice

UNIVERSITY OF ARKANSAS
DIVISION OF AGRICULTURE
Cooperative Extension Service

INSIDE

page 4
Impact of Water Acidifiers on Microbial Loads in Poultry Drinking Water
by Miranda Bowen and Susan Watkins

page 6
Coccidiosis and the Poultry Industry
by H. David Chapman

page 8
Nutrient Management: Air and Water Quality Issues
by G. Tom Tabler

page 10
Understanding and Controlling Ascites
by Frank T. Jones

Evaluation of Nipple Drinkers and the Lott System for Determining Appropriate Water Flow for Broilers

by J.M. Cornelison, A.G. Hancock, A.G. Williams, L.B. Davis, N.L. Allen and S.E. Watkins

Introduction

Water is thought by many to be the most important nutrient for poultry. Charles H. Goan summed up the true concerns of the broiler industry when he stated, “The purpose of any broiler watering system is to provide sufficient water for optimum bird growth and efficiency.” In recent years the industry has abandoned v-troughs, cups, and bell type drinkers in favor of nipple water systems. Nipple watering systems are advantageous because they improve water quality, eliminate the daily cleaning chores, and reduce spillage. Reduced water spillage creates dryer litter, decreases ammonia volatilization and reduces plant condemnations from breast blisters. Although, it is clear that nipple waterers are efficient, questions remain about proper management and drinker function.

It is important to realize that no two watering systems are identical. Numerous design differences exist, which dictate how each system must be managed with respect to water pressure (entering the regulator), waterline height, bird/nipple density, and flow rate or water column height. Thus, proper drinker management must be utilized for each system to achieve maximum bird performance.

Lott and coworkers used static flow measurements to generate guidelines designed to determine adequate nipple drinker flow. Static flow (milliliters of water delivered per minute) is measurement by triggering the nipple and timing the collection process for one minute. The “Lott flow method” uses the formula (Weeks of Age)* 7 + 20 to calculate necessary weekly static flow. However, this guideline creates several difficulties. First, it is important to realize that static flow measurements only provide an indication of how much water can flow, not how much water the bird consumes. For some drinker types the bird activates the nipple using a side to side action, not the straight up and down motion measured by static flow. Also, the bird uses quick pecking motions to obtain a drink as compared to the constant pressure used to trigger the pin in static flow measurements. Second, low flow drinking systems are designed differently than other systems and cannot achieve Lott’s suggested guidelines. This discrepancy has created confusion regarding whether or not low flow systems deliver adequate water to the birds and concerns about poor bird performance due to drinker selection. With this in mind, two trials were conducted to evaluate broiler performance using different drinker systems managed according to manufacturers operating procedures. The trials were designed to determine if the Lott flow formula is an appropriate method for evaluation of all drinker types. A second objective was to determine if all drinker systems tested supported similar bird performance.

Materials and Methods

The following seven drinkers were evaluated during these trials: CHORE-TIME® RELIA-FLOW™, Cumberland Nipple Drinking System, Plasson Nipple

WATER SYSTEM — continued on page 2

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

Drinker Line, Roxell SparkCup, Roxell SparkNipple, VAL-CO, and Ziggity Max3. Each was compared to a Val-Roaster drinker maintained according to the Lott requirements. The Roxell SparkCup drinking system was installed with two cups per pen.

Trial One

One thousand two hundred and eighty (1280) male boiler chicks (day-old) were randomly placed in 32 floor pens, allocating 40 birds/pen (1.25 sq. ft.) and 7 birds/nipple. There were four replication pens per drinker system. Water was supplied to each line via a plastic water tube feeding from two 5-gallon buckets that were elevated about four feet above the water line. All drinkers were managed according to manufacturers' recommendations and static flow was measured weekly. In the first trial, each nipple drinker line with the exception of the Plasson systems were equipped with regulators to maintain pressure rates.

Individual bird weights, feed consumption and water usage were measured on days 0, 7, 21, 35, and 42. The weight of all birds that died or were culled was recorded by pen and this weight was used to adjust feed conversion.

Trial Two

Two thousand two hundred (2200) male broiler chicks (day old) were randomly placed in 40 floor pens, allocating 55 birds/pen (.90 sq. ft.) and 9 birds/nipple. There were five replicate pens per drinker system. Water was supplied to each water line via the house main. In this trial, the Plasson drinkers were equipped with regulators. The flows for all drinkers were managed according to manufacturers' recommendations. However, for this trial the static flow was measured each time the line was adjusted instead of once a week. Pen weights of birds and feed consumption were measured on days 0, 7, 21, 35, and 42. Litter moisture was measured using a 250-gram sample collected from four locations directly under the water lines on day 42. The weight of all birds that died or were culled was recorded by pen and this weight was used to adjust feed conversion.

Nutrition and Management

Birds were fed diets formulated to meet the Cobb-Vantress nutrient recommendations. The starter diet was fed from 0 to 14 days, grower diet from 14 to 28, finisher I from 28 to 35 and finisher II from 35 to 49 days. The starter diet was fed as a crumble while the grower and finisher diets were fed in the pellet form. Diets were supplemented with Coban 60 and BMD at 1.5 and 1 pound per ton, respectively.

Birds were reared under a ventilation and temperature regime reflecting industry standards. The lighting program was 23 hours of light/day for the first four days followed by natural day length to 13 days of age and then birds were placed on 6 hours of darkness per day. The daily high-low temperatures were recorded. All birds received Fayetteville city water.

Results

The average weekly static flow measurements for each of the drinker systems are shown in Table 1. For all the drinkers except the Ziggity Max3, the flows were similar for both trials. In the first tiral, the Ziggity Max3 was kept at a static flow

Table 1. Average Weekly Static Flows for the Different Drinker Types[1]

Drinker	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
	----------	----------	----------	(mL/min)	----------	----------
CHORE-TIME	17.4	19.0	19.2	25.4	31.8	37.3
Cumberland	15.7	18.1	18.1	25.5	28.9	29.6
Lott	26.6	34.1	40.7	47.9	55.5	62.3
Plasson Nipple	20.7	26.9	26.1	42.9	46.0	60.0
SparkCup	----	----	----	----	----	----
SparkNipple	40.5	65.5	79.5	88.8	98.2	98.5
VAL-CO	20.6	26.4	32.0	38.6	46.2	54.2
Ziggity	9.5	12.5	15.0	18.9	24.0	29.5
SEM	1.34	1.23	1.83/1.64	1.45	1.29	1.58/1.41
P Value	.0001	.0001	.0691	.0001	.0001	.0001

[1] Results are an average for both trials

of 10 ml/minute for the first four weeks. In the second trial the flow for this drinker was 10, 15, 20 and 27 ml/minute for weeks 1, 2, 3 and 4, respectively. Static flow could not be measured for the SparkCup line, because this line was a cup system. The data indicate that the drinkers managed according to the Lott flow guidelines were maintained almost exactly according to the recommendations. While statistically significant differences were found in static flows, only the Roxell SparkNipple produced higher static flow than the Lott recommendations. Yet no statistical differences were seen for body weights at any of the periods

Table 2. Average Weights of Male Broilers Reared on Different Drinker Systems

Drinker	Day 7		Day 21		Day 35		Day 42	
	(lbs)							
	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
CHORE-TIME	.429	.372	2.308	2.006	5.102	4.853	6.767	6.492
Cumberland	.429	.376	2.299	2.000	5.122	4.884	6.651	6.417
Lott	.429	.378	2.332	2.020	5.091	4.886	6.706	6.508
Plasson Nipple	.436	.376	2.290	2.033	5.095	4.893	6.635	6.459
SparkCup	.427	.389	2.279	2.015	5.159	5.005	6.763	6.646
SparkNipple	.416	.378	2.275	2.010	5.047	4.917	6.622	6.340
VAL-CO	.429	.372	2.330	2.011	5.135	4.913	6.734	6.477
Ziggity	.416	.376	2.242	2.037	4.970	4.917	6.453	6.466
SEM	.007	.007	.024	.022	.049	.044	.079	.071
P Value	.5806		.2822		.4268		.5419	

measured (Table 2). Though not significant, in trial one on day 42 broilers reared on Ziggity Max3 drinkers weighed slightly less than birds on other systems. This reduction in weight was because the drinker was managed at very low static flows (less than 10 ml/minute) for the first four weeks. It is important to note that the body weights of broilers reared on the Ziggity Max3 in the second trial were similar to the weights of broilers reared on the other drinker systems. This result provides a strong case against limiting drinker flow and demonstrates that only a slight increase or decrease in flow rates can have a significant impact on bird performance. No statistical differences were seen between drinker types with respect to feed conversion or overall mortality (Tables 3 and 4).

Table 3. Feed-to-Gain Ratios for Male Broilers Reared on Different Drinkers[1]

Drinker	Day 7	Day 21	Day 35	Day 42
	(g:g)			
CHORE-TIME	.853	1.250	1.479	1.614
Cumberland	.847	1.256	1.493	1.643
Lott	.849	1.243	1.481	1.623
Plasson Nipple	.849	1.262	1.524	1.639
SparkCup	.857	1.250	1.465	1.619
SparkNipple	.843	1.252	1.487	1.639
VAL-CO	.864	1.251	1.490	1.620
Ziggity	.864	1.251	1.489	1.613
SEM	.008	.007	.013	.010
P Value	.6440	.7423	.1210	.7284

[1] Results are an average for both trials

Table 4. Mortality of Male Broilers Reared on Different Drinker Systems[1]

Drinker	Day 7	Day 21	Day 35	Day 42
	(%)			
CHORE-TIME	.625	2.55	2.91	3.72
Cumberland	.182	1.58	1.77	2.08
Lott	.807	2.96	3.46	4.50
Plasson Nipple	.182	1.74	2.91	4.66
SparkCup	.625	1.93	3.09	5.12
SparkNipple	.545	1.66	2.60	3.41
VAL-CO	.625	1.35	1.84	2.83
Ziggity	.676	1.85	2.83	2.83
SEM	.41	.73	.79	.99
P Value	.9456	.8007	.7888	.3507

[1] Results are an average for both trials

Water usage data expressed as water-to-gain ratio is shown in Table 5. At day 7 the birds on the Plasson and Cumberland drinking systems used significantly more water.

WATER SYSTEM — continued on page 4

However, this trend did not continue and there were no statistical differences in consumption among the different lines for the remainder of the trial. Water consumption could not be measured on the SparkCup drinker, because the line requires high water pressure entering the regulator to operate properly. Also, water pressure entering the regulator for the CHORE-TIME line could not be maintained once the birds were four weeks old. At this time, the line was connected to the house main.

Litter moisture values obtained from samples collected under each drinker line are shown in Table 6. Highest moistures were obtained from litter collected beneath SparkNipples, while lowest values were found under the Cumberland system. It is important to note that the litter samples were collected from directly underneath each drinker line, thus the amount of moisture was not representative of the entire pen.

Table 5. Average Water-to-Gain Ratio for Male Broilers on Different Drinker Systems[1]

Drinker	Day 7	Day 21	Day 35	Day 42
	(g:g)			
CHORE-TIME	1.79ab	2.25	----	----
Cumberland	1.93a	2.24	2.60	2.71
Lott	1.79ab	2.25	2.65	2.75
Plasson Nipple	1.91a	2.25	2.60	2.76
SparkCup	----	----	----	----
SparkNipple	1.71b	2.27	2.60	2.71
VAL-CO	1.69b	2.27	2.58	2.72
Ziggity	1.65b	2.20	2.47	2.60
SEM	.055	.05	.04	.04
P Value	.0101	.9506	.1265	.1499

[1] Results are for trial 1 only.

Table 6. Impact of Different Drinker Systems on Litter Moisture[1]

Drinker	Moisture (%)
CHORE-TIME	39.00abc
Cumberland	27.64d
Lott	34.88bcd
Plasson Nipple	43.94ab
SparkCup	29.16cd
SparkNipple	47.26a
VAL-CO	36.82bcd
Ziggity	28.36cd
SEM	3.07
P Value	.0002

[1] Results for Trial 2 only

Conclusion

During the two trials, broiler performance was evaluated on 8 drinker lines managed according to manufactures operating procedure. The trials confirm that no two drinker systems are managed the same and that proper management of watering systems is essential for maximum broiler performance. The trials indicate that static flow rates vary significantly among the different lines tested. In addition, the results indicate that while helpful, the Lott flow formula isn't necessarily the best tool for managing the flow on all drinkers. On the other hand, measuring static flow of drinkers can help to identify inconsistencies in watering systems both within a farm, within a house and even within a line. Thus, static flow measurements are valuable tools when used correctly. However, it is most important to know and follow the manufacturer's recommendations for the particular drinker system for optimum results.

Miranda Bowen and Susan Watkins
Center of Excellence for Poultry Science • University of Arkansas

Impact of Water Acidifiers on Microbial Loads in Poultry Drinking Water

Case Study

A broiler producer called with a complaint about flock performance. He explained that he used iodine for 2-3 days and then would switch the birds to an acidifier. While the birds were on the iodine, the droppings remained firm. Once the birds were switched to the acidifier, the bird droppings became loose. The producer was advised to keep the birds on either iodine or household bleach (used at a rate of 4 ounces/gallon stock solution then 1 ounce of stock to a gallon of water) and skip the acidifier. Bird performance improved. While the obvious response was to keep the birds on the iodine, it was puzzling that the commonly used acidifier had this impact. Yet, acidifier products typically have one size fits all preparation and mixing directions that do not take into consideration the natural buffering capacity of the water being treated. In fact, since bacteria can become resistant to acid treatments, this one size fits all approach to water treatment could enhance bacterial growth rather than limit it. We therefore conducted a little experiment to determine how acidifiers might be impacting bacterial growth in the water.

Purpose: To test the effect of different chemicals used to adjust water pH on the survival of bacteria.

Materials & Methods

Water with a pH greater than 8 was obtained from a local farm. This water was blended with dirty water from a breeder plasson and then incubated for 72 hours at 86°F (30°C). After determining initial aerobic bacterial count (control) and pH, the water was divided into 50 ml portions. The following treatments were used to adjust dirty water samples to pHs of 7, 6, 5 and 4: Citric Acid, Dry Vin, Hydro-Clean, and Poultry Water Treatment (PWT). One 50 ml portion was used for each pH level and treatment tested. Table 1 contains data describing the preparation and characteristics of the products tested.

Table 1. Preparation and Characteristics of Water Treatment Chemicals

Product Name	Label Directions	Amount added/ gallon (grams)	Initial pH of stock solution
Citric Acid	2 Packs / gal	815.6	1.16
DryVin	1 Pack / 2 gal	190.7	1.68
Hydro-Clean	1 Pack / gal	258.4	1.5
PWT	1 Pack / gal	414.6	1.06

Each portion of pH adjusted dirty water sat for 5 minutes before plating to determine aerobic bacterial count (APC). APC was reported in colony forming units per ml (CFU/ml).

Table 2. Amount Required to Obtain Desired pHs from a Initial pH of 8

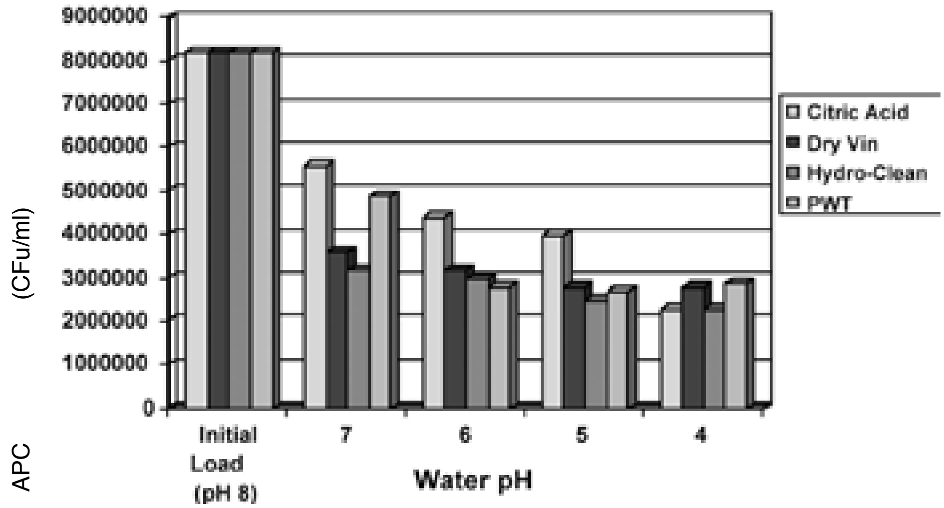
Product	pH 7	pH 6	pH 5	pH 4
Citric Acid	0.1 ml	0.3 ml	0.6 ml	1.05 ml
DryVin	0.9 ml	2.4 ml	5.6 ml	10.9 ml
Hydro-Clean	0.7 ml	2.2 ml	5.2 ml	9.7 ml
PWT	0.5 ml	1.7 ml	3.55 ml	5.55 ml

Results and Conclusion

The data in Figure 1 illustrate the fact that none of the treatments reduced the initial bacterial count of 8.2 million to below one million CFU/ml. Thus, the selected treatments had essentially no effect on the growth of the bacteria at pHs of 7, 6, 5 and 4. These data suggest that adjusting the pH down to the range of 4 and 5 was not enough to reduce aerobic plate count populations in water which already had a heavy microbial load. Although additional experiments are necessary to draw final conclusions, these results suggest that in heavily contaminated systems the use of acidifiers alone may not be enough to improve water quality. This confirms that water acidifiers should be used in conjunction with water sanitizers such as chlorine, iodine or chorine dioxide.

CASE STUDY — continued on page 6

Figure 1. Aerobic Plate Counts (APC) from Treated Water



H. David Chapman
Center of Excellence for Poultry Science • University of Arkansas

Coccidiosis and the Poultry Industry

Coccidiosis

Coccidiosis is a parasite infection of chickens that in the past caused catastrophic losses to the developing poultry industry in the United States. Today, thanks to the discovery of many effective drugs, the disease is well controlled. Indeed, it is doubtful if the industry could have reached its present size without effective means to control coccidiosis. We should be on our guard however, because the causative organism (a microscopic parasite with the scientific name *Eimeria*) is still present in most poultry flocks. Eradication has proved impossible. Therefore we should be aware of the conditions that make coccidiosis a threat to the health of our birds.

...we should be aware of the conditions that make coccidiosis a threat to the health of our birds.

The Life Cycle

The parasite completes its life cycle in the intestine of the bird, multiplying in the cells that digest and absorb nutrients and eventually destroying them. Two of the commonest species (*Eimeria acervulina* and *Eimeria maxima*) develop in the mucosa of the anterior and mid intestine and the malabsorption that accompanies destruction of host cells results in poor growth and impaired feed conversion. Another common and widely known species is *Eimeria tenella* that develops in the paired cecal pouches where it damages the entire mucosa; this results in hemorrhage (with blood in the droppings) and, in severe cases, death of the bird. *Eimeria necatrix* also causes hemorrhage but, in the small intestine rather than the ceca. It is most frequently found in older birds reared for egg production.

Transmission

The transmission stage of the parasite is a microscopic egg shaped cyst (known as the oocyst). Oocysts are shed in the droppings and undergo a process known as sporulation that takes 24-48 hours; after this the oocyst is infective if ingested by a bird. An important aspect of the life cycle of these parasites is that the severity of the disease is proportional to the number of sporulated oocysts ingested. Thus, management of the disease requires the adoption of sanitary and hygienic procedures to reduce the level of exposure to infection. Sporulation is favored by moisture. Therefore it is important to maintain dry litter, especially around drinkers and feeding areas. Maintaining dry litter will reduce oocyst numbers and the likelihood that birds will be exposed to parasite numbers that will cause clinical coccidiosis.

Control

Control of coccidiosis has been achieved by the use of drugs that kill the parasite before it can develop in the chicken. In the 1950's and occasionally today, drugs were often included in the drinking water to treat sick birds. Unfortunately the onset of coccidiosis is rapid and the signs of disease (such as huddling, ruffled feathers, off feed) are seen with many other poultry diseases. Treatment often came too late to prevent serious production losses. A preventative approach is therefore desirable and this is achieved by incorporation of drugs in the starter and grower feeds. The most widely used drugs are known as ionophores. These compounds inhibit the development of the parasite but, do not prevent the acquisition of natural immunity by the bird so that they can be withdrawn from the feed well before the birds are sold. The poultry industry has devised many programs using drugs for the control of coccidiosis. Yet coccidosis organisms can quickly become resistant to drugs. Thus, in the spring and early summer "shuttle" programs are often employed in which a synthetic drug (so called "chemicals") is incorporated in the starter feed and an ionophore in the grower. Rotation programs in which different drugs are used in successive flocks have also been widely adopted.

Vaccines

An entirely different approach to the control of coccidiosis involves the use of vaccines. Vaccines in which birds are administered small numbers of sporulated oocysts have long been available in the USA. In the past vaccines have principally been employed during the rearing phase of egg-laying birds. The introduction of novel methods of administration (such as with a spray-cabinet in the hatchery) has made vaccination of broilers more feasible. Researchers are actively seeking better means to safely immunize birds against coccidiosis and although there are many technical hurdles to overcome, progress is being made and new vaccines seem likely in the future.

Problems

As is often the case, success in controlling a disease is often accompanied by a downside. In the case of the coccidiosis parasite *Eimeria* has proved to be very adaptable, eventually acquiring resistance to the widely used drugs. It has therefore been necessary to constantly discover new compounds to replace those that are no longer effective. Unfortunately, this process is now vastly expensive and many companies have been discouraged from pursuing new drug discovery. Vaccines are seen as a likely alternative but, the decreased funding available for basic research into, for example, mechanisms of immunity may prevent progress in the future.

Management

As long as chickens are raised on the ground and therefore in contact with their feces, then coccidiosis will remain a threat to the poultry industry. Good management however, plus the adoption of effective control programs, whether by chemotherapy or vaccination, can serve to reduce the risk. In 1991, following the first ever flock of broilers raised at the University of Arkansas Applied Broiler Research Farm at Savoy, we identified three species of *Eimeria* present in the litter. These species are still present today after many flocks have been successfully raised on the site. By a combination of good management and adoption of control programs recommended by the integrator, coccidiosis has not so far been a problem. It is hoped that this situation will continue in the future.

A chicken is shown above exhibiting symptoms of coccidiosis, a parasite infection that in the past has caused catastrophic losses to the industry.

G. Tom Tabler
Center of Excellence for Poultry Science • University of Arkansas

Nutrient Management: Air and Water Quality Issues

Introduction

The countryside has long been the place to live or retreat to for fresh air and clean water. However, rural America is also home to production agriculture that feed this country and much of the rest of the world. As farms become fewer in number, yet larger in size, nutrient management becomes an increasingly difficult concern for farmers as well as the general public, governmental agencies at the local, state and national level. Arkansas poultry farms are a perfect example of this dilemma. Poultry litter may simultaneously affect more than one environmental medium (such as both air and water quality). Unfortunately, most current environmental laws tend to ignore the big picture to focus on specific environmental areas (e.g., Air in the Clean Air Act and Water in the Clean Water Act). Yet comprehensively addressing regulatory concerns avoids unnecessary costs to producers and assists in efficiently dealing with environmental issues.

Without question, we currently have access to more data concerning water quality than air quality.

Arkansas Rule Changes

Without question, we currently have access to more data concerning water quality than air quality. So much so that in 2003, the EPA introduced revised Clean Water Act regulations to better protect surface waters from nutrients from concentrated animal feeding operations (CAFOs). As a result, when applying manure to crop or pasture land (still the most common disposal method), CAFOs must now follow a nutrient management plan that specifies a manure application rate that minimizes the threat to water quality.

The situation in Arkansas is such that starting January 1, 2006, dry poultry litter may only be applied in accordance with a nutrient management plan or at the maximum application rate of 1.5 tons per acre. Starting January 1, 2007, the maximum application rate of 1.5 tons per acre will no longer be valid and dry poultry litter must only be applied in accordance with a nutrient management plan. Also, anyone applying nutrients to an area greater than 2.5 acres is required to become a certified nutrient applicator, regardless of whether poultry litter or commercial fertilizer is being applied. The training curriculum is the same for either a private or commercial applicator. However, the fees are different, $30 for a private and $60 for a commercial, and commercial applicators are required to take an exam following the training and pay an exam fee. You may contact your local county extension office if you have questions or need additional information.

Emission Concerns

While water quality has been a concern for a number of years, as farming operations become larger through consolidation and increasing numbers of people have moved from cities to rural areas, agricultural air quality has become a major issue. Air quality is regulated by the Clean Air Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Clean Air Act sets limits on how much of a given pollutant can be in the air anywhere in the United States.

Regulation of air emissions under the Clean Air Act and CERCLA has, until recently, focused on sources such as factories and cars, not agricultural emissions. However, agricultural emissions now have the attention of the federal government and changes to air quality regulations that may affect how you manage your operation are likely forthcoming. States are responsible for abiding by the Clean Air Act. Recent lawsuits, court decisions, and consent agreements have spurred some states to begin regulating agricultural emissions. California was the first state to implement air quality regulations that significantly affect agriculture. However, without careful planning and consideration of nutrient regulations already in place, implementation of new air quality regulations may create a nightmare for producers.

Emissions from agricultural facilities to the atmosphere do not occur in isolation. Biological and chemical processes ensure that water and air pollution concerns are closely linked. For example, when poultry litter is spread on a field, some of the nitrogen is volatilized into the atmosphere, which lessens the amount that may wind up in the soil profile and therefore, decreases the risk to water quality. However, the amount that is volatilized increases the risk to air quality by creating odors, contributing to fine particulates (haze), and hastening global climate change (National Research Council, 2003).

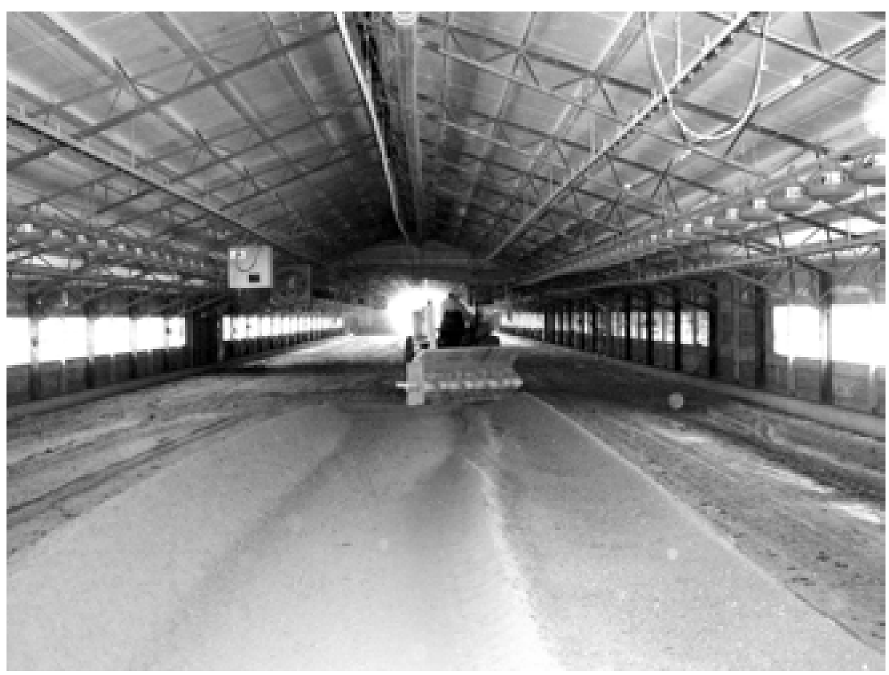
Multimedia Approach

The current uncoordinated approach to air and water quality regulation has potentially costly implications for both animal producers and society in general (Aillery et al., 2005). Some animal feeding operations already subject to water quality regulations may soon be required to meet ammonia emission regulations as well. Technologies adopted to reduce water pollution may be inadequate for meeting both water and ammonia requirements, and might have to be abandoned or modified, at some cost, to comply with both sets of regulations (Aillery et al., 2005).

The increasing size and geographic concentration of animal feeding operations, driven by the economics of domestic and export markets for animal products have resulted in large quantities of nutrients accumulating in relatively small areas. According to a 2003 National Academy of Sciences study, animal feeding operations are the primary source of ammonia emissions in the U.S., and ammonia emissions are already a concern in some rural areas (Ribaudo and Weinberg, 2005). Additional data is certainly needed regarding air emissions from animal agriculture and efforts are currently underway on several fronts to provide this information. It would appear more advantageous to use this data, when available, in combination with water quality efforts already in place rather than develop a completely independent air quality program.

Within the past 10 years, the EPA has developed integrated air and water rules that set emission levels and has coordinated implementation of the Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act (which deals with hazardous waste disposed on land). This approach is designed to decrease implementation costs and assist regulated industries in the efficient organization of pollution control activities through a combination of source reduction technologies and management practices, air pollution control devices, and upgrades on existing wastewater treatment systems (Ribaudo and Weinberg, 2005).

Would such a coordinated implementation effort be advantageous to the poultry industry? At present many producers are not aware of their operation's contribution to emissions or whether they are subject to existing air quality regulations. Knowing the legal and financial risks for different operations would help producers make proper decisions, avoid lawsuits and remain in business. Also, it should be kept in mind that a coordinated effort that benefits both air and water quality is likely much more workable than two independent systems where benefits to one is at the expense of the other.



Summary

The Clean Water Act has regulated many CAFOs since 1974; many more (including a number of dry-litter poultry farms) will be regulated as a result of strengthening of regulations in 2003. Air emissions from animal agriculture (including poultry houses) are currently attracting much local, state and national attention. Poultry producers should monitor the situation closely as this will likely affect your operation in the near future. A number of new regulations regarding nutrient management and spreading litter will soon go into effect for Arkansas poultry producers. Stay current on rule changes to avoid serious legal issues. Contact your local county extension office with questions.

References

Aillery, M, N. Gollehon, R. Johansson, J. Kaplan, N. Key, and M. Ribaudo. 2005. Managing manure to improve air and water quality. USDA ERS. Economic Research Report 9.

National Research Council. 2003. Air emissions from animal feeding operations: Current knowledge, future needs. Ad Hoc Committee on Air Emissions from Animal Feeding Operations, Committee on Animal Nutrition, National Research Council, National Academy Press, Washington, DC.

Ribaudo, M.and M. Weinberg. 2005. Improving air and water quality can be two sides of the same coin. Amber Waves. Sept.

Frank T. Jones
Center of Excellence for Poultry Science • University of Arkansas

Understanding and Controlling Ascites[1]

Ascites is the accumulation of fluid in the abdominal cavity. It has been observed worldwide in fast-growing broilers.

Introduction

The ascites has been observed worldwide in fast growing broilers reared under a wide variety of conditions. Ascites is initiated by factors that elevate the blood pressure within arteries supplying the lungs. This increase in pulmonary arterial pressure (hypertension) triggers the accumulation of fluid in the abdominal cavity (ascites). Since several seemingly independent factors contribute to the overall incidence of ascites, attempts to manage ascites can be confusing unless we are able to focus on a unifying strategy. The objectives of this article are to summarize the progression leading from pulmonary hypertension to terminal ascites, to provide an understanding of how pulmonary hypertension can begin and to suggest ways to reduce the chances of your flock getting the disease.

How Birds Breath

While some may already understand, before beginning our discussion of ascites, it is important to have a basic understanding of how respiration (breathing) takes place in birds. The process of respiration in birds is similar in some ways to respiration in mammals. Blood in need of oxygen is brought from the tissues through the veins (venous blood) to the heart and pumped to the lungs for oxygenation. Oxygen rich blood leaves the lungs and returns to the heart and pumped to body tissues. Arteries carry blood (arterial blood) from the heart to other organs or tissues.

Although birds have lungs, they are small and rigid in comparison to those of mammals. Birds have no true diaphragm. Instead, birds have a series of thin walled pouches called air sacs connected to their lungs. Respiratory muscles move the keel bone to push air in and out of the birds in a manner similar to a bellows. The exchange of oxygen and carbon dioxide occurs only in the lungs and avian lungs are much less capable of expansion than are mammalian lungs. Yet avian lungs are more efficient than mammalian lungs at gas exchange and air sacs effectively move large volumes of air through the respiratory system. Thus, any condition that interferes with the air sacs hinders respiration. In addition to their role in respiration, air sacs help remove excess heat from the bird's body and can act as shock absorbers, protecting internal organs.

How Pulmonary Hypertension progresses to Ascites

Venous blood from the bird's body first enters a collecting chamber of the heart called the right atrium and then passes through a simple flap-like valve into a pumping chamber called the right ventricle. The right ventricle normally pumps at a low pressure that is just sufficient to push all of the returning venous blood through the blood vessels of the lungs. Maintaining this low pumping pressure reduces the work load of the heart and prevents swelling and fluid accumulation in the lungs (pulmonary edema). When excessive blood flow causes the heart to increase pressure to the lung (pulmonary hypertension), the relative inflexibility of the lungs causes fluid from the blood vessels to begin to move into the lung tissues. Soon after it begins, pulmonary hypertension causes the wall of the right ventricle to thicken, indicating it is performing increased work to pump blood through the lungs. Research has demonstrated that increases in the relative weight of the right ventricle are directly correlated with increases in blood pressure in the arteries leading to the lungs (pulmonary arteries). In addition, recent experiments have shown that elevations in pulmonary arterial pressure can cause blood to flow so rapidly through the lungs of healthy broilers that insufficient time elapses for adequate oxygen uptake. This rapid blood flow causes blood oxygen levels to gradually decline in affected broilers which can be detected visually as a slight darkening of the normally bright red comb and wattles. Pulmonary edema also may contribute to reduced blood oxygenation as pulmonary hypertension progresses.

After initially thickening, the wall of the right ventricle then begins to stretch and enlarge.

This enlargement indicates that in spite having increased the pulmonary arterial pressure, the right ventricle still cannot pump all of the blood through the lungs. The volume within the right ventricle must increase when an excessive amount of blood remains within the pumping chamber at the completion of contraction. This enlargement physically reduces the pumping efficiency of the right ventricle, and extensive enlargement may prevent the valve between the right atrium and right ventricle from sealing properly, allowing blood to regurgitate back into the right atrium during each ventricular contraction. The reduced blood oxygen levels accompanying pulmonary hypertension may contribute to a generalized weakening of heart muscle. These events mark the beginning of right-sided congestive heart failure, which is characterized by the engorging of veins throughout the body with blood that cannot be efficiently pumped through the lungs. The accumulated blood congests the blood channels within the liver and causes plasma leakage through the surface of the liver. This plasma is the source of the fluid which accumulates in the abdominal cavity and eventually kills the bird by compressing the abdominal air sacs so that respiration can not occur. As the syndrome enters its terminal stages, large reductions in blood oxygen cause the comb and wattles of affected broilers to exhibit a dark blue "cyanotic" appearance.

What Causes Pulmonary Hypertension?

Since ascites starts with pulmonary hypertension, strategies to reduce the incidence of ascites in fast growing broilers must focus on the underlying causes of pulmonary hypertension. Broilers that are susceptible to ascites are capable of outgrowing the capacity of their lungs to accept and oxygenate blood at a sufficiently low pulmonary arterial pressure. Detailed anatomical studies have shown that, on a body weight basis, the process of domestication has reduced the pulmonary gas exchange capacity of both chickens and turkeys. Selection for improved feed efficiency and rapid body weight gain may have unintentionally contribute to a marginal pulmonary capacity making birds less capable of sustained activity.

The metabolic demands associated with fast growth in broilers constantly challenge the heart to pump higher volumes of blood as a source of nutrient and oxygen delivery. Recent research clearly demonstrates that broiler lungs maintain an essentially constant resistance during large increases in blood flow. This means that broiler lungs can only expand so much and are functionally inelastic. This inelasticity means that pulmonary blood pressure must increase in order to propelled the increased blood flow through the lungs. When the volume of blood pumped by the heart per minute (known as the cardiac output) increases in fast growing broilers, pulmonary hypertension must occur since resistance in the lungs (pulmonary vascular resistance) can not be reduced to accommodate the increased volume of blood returning to the heart.

Factors that Trigger Pulmonary Hypertension and Ascites

Ascites mortality tends to be highest in the fastest growing flocks, and that incidence can be lowered by any strategy that slightly slows the overall flock growth rate. This slightly slower growth rate reduces the demand on the heart, pulmonary hypertension and ascites.

The incidence of ascites increases whenever broilers are exposed to cool temperatures. Cool temperatures increase cardiac output since the bird's metabolic rate must increase to meet the demand for body heat production.

Exposing broilers to low oxygen immediately triggers an increase in pulmonary arterial pressure since the efficiency of respiratory process is reduced. When birds are chronically exposed to low oxygen levels, it tend to lead to a high incidence of ascites.

The respiratory damage associated with disease, dust, or poor air quality can reduce respiratory efficiency. In addition, these conditions can partially obstruct the airways, reduce the number of vascular channels available for blood flow, thereby reducing blood oxygen, increasing pulmonary vascular resistance and pulmonary arterial pressure, and causing ascites in broilers.

Lowering the Odds of for Pulmonary Hypertension and Ascites

In contrast to the known triggers for ascites outlined above, the incidence of ascites can be lowered by any strategy that reduces the metabolic demand for oxygen and thus reduces cardiac output. Slightly restricting broiler growth rates and providing thermoneutral temperatures fall into this category. The incidence of ascites also can be reduced by treatments that reduce pulmonary vascular resistance by dilating the pulmonary vasculature. Although a number of chemical are capable of reducing pulmonary vascular resistance, none are approved for use in birds destined for human consumption. However, the amino acid arginine is utilized by cells lining the pulmonary blood vessels to facilitate pulmonary vascular dilation during high pressure and flow conditions. Our research has shown that adding supplemental arginine to broiler diets effectively reduces pulmonary vascular resistance and the incidence of ascites in broilers exposed to cool temperatures. Nonetheless, it is important to remember that increased use dietary arginine have been shown to influence lysine requirements.

Conclusion

Broilers susceptible to ascites are capable of outgrowing the capacity of their lungs to oxygenate blood. Factors that increase oxygen demand include: exposure to cool temperatures, low oxygen levels, and respiratory damage associate with disease, dust or poor air quality. Pulmonary hypertension and ascites in modern broiler strains may be reduced by any strategy that reduces the metabolic demand for oxygen and thus reduces cardiac output. Slight restrictions in broiler growth and providing a thermoneutral environment are two strategies that work.

---

[1] This article was largely abstracted from a 1999 Hubbard Farms Technical Report by R. F. Wideman ("Understanding pulmonary hypertension syndrome (ascites)"). This article is published with the permission of the author and Hubbard Farms.

Write Extension Specialists,
except Jerry Wooley, at:
Center of Excellence
for Poultry Science
University of Arkansas
Fayetteville, AR 72701

UA Poultry Science Extension Faculty

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

Dr. Dustan Clark, Extension Poultry Health Veterinarian, earned his D.V.M. from Texas A&M University. He then practiced in Texas before entering a residency program in avian medicine at the University of California Veterinary School at Davis. After his residency, he returned to Texas A&M University and received his M.S. and Ph.D. Dr. Clark was director of the Utah State University Provo Branch Veterinary Diagnostic Laboratory prior to joining the Poultry Science faculty at the University of Arkansas in 1994. Dr. Clark's research interests include reoviruses, rotaviruses and avian diagnostics. He is also responsible for working with the poultry industry on biosecurity, disease diagnosis, treatment and prevention.
Telephone: 479-575-4375, FAX: 479-575-8775, E-mail: fdclark@uark.edu

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

Dr. John Marcy, Extension Food Scientist, received his B.S. from the University of Tennessee and his M.S. and Ph.D. from Iowa State University. After graduation, he worked in the poultry industry in production management and quality assurance for Swift & Co. and Jerome Foods and later became Director of Quality Control of Portion-Trol Foods. He was an Assistant Professor/Extension Food Scientist at Virginia Tech prior to joining the Center of Excellence for Poultry Science at the University of Arkansas in 1993. His research interests are poultry processing, meat microbiology and food safety. Dr. Marcy does educational programming with Hazard Analysis and Critical Control Points (HACCP), sanitation and microbiology for processing personnel. Telephone: 479-575-2211, FAX: 479-575-8775, E-mail: jmarcy@uark.edu

Dr. Susan Watkins, Extension Poultry Specialist, received her B.S., M.S. and Ph.D. from the University of Arkansas. She served as a quality control supervisor and field service person for Mahard Egg Farm in Prosper, Texas, and became an Extension Poultry Specialist in 1996. Dr. Watkins has focused on bird nutrition and management issues. She has worked to identify economical alternative sources of bedding material for the poultry industry and has evaluated litter treatments for improving the environment of the bird. Research areas also include evaluation of feed additives and feed ingredients on the performance of birds. She also is the departmental coordinator of the internship program.
Telephone: 479-575-7902, FAX: 479-575-8775, E-mail: swatkin@uark.edu

Mr. Jerry Wooley, Extension Poultry Specialist, served as a county 4-H agent for Conway County and County Extension Agent Agriculture Community Development Leader in Crawford County before assuming his present position. He has major responsibility in the Arkansas Youth Poultry Program and helps young people, parents, 4-H leaders and teachers to become aware of the opportunities in poultry science at the U of A and the integrated poultry industry. He helps compile annual figures of the state's poultry production by counties and serves as the superintendent of poultry at the Arkansas State Fair. Mr. Wooley is chairman of the 4-H Broiler show and the BBQ activity at the annual Arkansas Poultry Festival.
Address: Cooperative Extension Service, 2301 S. University Ave., P.O. Box 391, Little Rock, AR 72203