

CORNELL POULTRY POINTERS

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Barb Smagner, Managing Editor

A REMINDER THE 2000 CORNELL POULTRY CONFERENCE IS WEDNESDAY, JUNE 21st

We would like to remind you that the date for the 2000 Cornell Poultry Conference is Wednesday, June 21. Every effort has been made so that the topics will be directly relevant to your business. It will a day that not only you will be able to learn about the latest scientific and technological advances related to your business, but also provides an opportunity to see and talk to your friends. We would like to encourage all of you to attend this one-day conference which is specifically arranged for your business. Enclosed with this issue of Poultry Pointers is a copy of the program.

*K. Keshavarz
Department of Animal Science
Cornell University*

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ARE YOU READY FOR THE HOT WEATHER OF SUMMER MONTHS?

The hot summer months are fast approaching. It is not too early to consider the proper steps that should be taken for minimizing the adverse effects of environmental temperature of summer months on performance of your flocks. Past experience has shown that even poultry producers in New York and New England states cannot be immune from the adverse effects that the high temperatures of summer months could have on performance of their laying flocks. The following are a number of suggestions for diminishing the adverse effects of elevated environmental temperatures on performance of your birds.

1) The major factor that contributes to reduced production performance during the summer months is reduced feed intake which results from decreasing the daily energy need for maintaining the body temperature constant. This, in turn, results in inadequate intake of essential nutrients. Consequently, you should keep accurate information about the daily feed intake of every flock and by using more dense diets, efforts should be made so that nutrient intake is not affected due to decreased feed intake.

2) You can maintain the energy content of the diet constant. However, replace some part of the carbohydrate calorie with fat calorie. The heat increment (specific dynamic effect, SDE, which increases the heat load of the body) associated with utilization of fat is considerably lower than that attributed to

utilization of carbohydrates and proteins. Consequently, replacing some part of the carbohydrate calories with fat calories reduces the internal body heat and help increase feed consumption. Additionally, it has been shown that fats have an ameliorating effect on SDE of carbohydrates and proteins. This beneficial effect of fats is referred to as "associated dynamic effect". Consequently, with isocaloric diets, supplementing laying hen diets with 2-4% fat during the summer months has two advantages: it stimulates daily feed consumption due to increasing the palatability of the diet, and it reduces the heat production associated with utilization of carbohydrates and proteins. This approach can be used in feed formulation for broilers, pullets, turkeys, and laying hens.

3) Because SDE of fats is lower than carbohydrates, therefore, for a similar metabolizable energy intake, more net energy would be available to hens when the diet contains about 2-4% fat as compared to a diet with no supplemental diet. Additionally, fat reduces the rate of passage of ingesta from the digestive system, and consequently, increases the time of contact of digestive enzymes with ingesta. This can increase the digestibility of nutrients. Overall, you should expect to see improvement in feed conversion due to the use of 2-4% fat in isocaloric diets.

4) Reduce the protein content of the diet as much as possible by using synthetic amino acids. Although several amino acids are currently available in the market with a reasonable price, you should probably only think about using synthetic methionine (or methionine hydroxy analogue, MHA) and lysine. Reducing the daily protein intake while maintaining the level of crucial amino acids adequate, has the advantage of reducing the daily heat production associated with SDE of proteins. Reducing protein, also

reduces the stress on kidneys for removing the end-products of protein metabolism, and this helps in reducing the ammonia level in poultry houses.

5) Particular attention should be paid to prevent nutrient imbalances. Nutrient imbalances (such as amino acid imbalance), increase the heat production associated with SDE: because the excess nutrients should be oxidized and eliminated and this contributes to internal body heat build up.

6) Make every effort to reduce the birds' activity which contributes to heat production. Reduce your visitation to a minimal for reducing the birds' activity. If possible, consider the use of an intermittent lighting program during the summer months (e.g., 1L-3D). This is expected to reduce the heat production associated with the hens' activity, and this, in turn, could have a positive effect on economics of daily feed and energy consumption. In fact, the suggested lighting program of Purina which consists of 16 hours light and 8 hours darkness per day (16L-8D) from 18 to 36 wk of age, and thereafter, 15 min L and 45 min D for a total of 4 hours light per day and from week 36 to the end of the production cycle, is claimed to improve the efficiency of feed conversion and reduce shell breakage. Remember, this lighting program cannot be used with fluorescent bulbs that are currently used in many poultry houses.

7) The ventilation system of the house not only should function at its maximum capacity during the light hours, but it should also be kept on during the dark hours of the night. This approach has a cooling effect on birds and stimulates feed consumption during the early hours of the morning.

8) Consider using midnight feeding, particularly during the high temperatures of summer months. These hours are the times when laying hens should make up for the

low feed, energy and other nutrient intake during the hot hours of the daytime.

9) Most of the poultry houses in the south and southeast of the U.S. are equipped with some kind of cooling system (fogging system or cooling pads). Due to the fewer days of high temperatures in summer months in the northeast, the cooling systems have not been considered as a requirement in the construction of poultry houses. The cost of equipping a 60,000 laying house with a mist system is minimal. This is a one time investment that in the long term may be to your advantage. Several years ago, when the house temperature during the summer months in our research facility suddenly increased to about 95° F and we lost many hens at peak production due to heat prostration (build up of body heat). Since we have equipped the building with an automated mist generating system, we have not experienced any abnormal mortalities during the summer months, although we have been experiencing summer temperature rises of at least about 95° F. The cooling effect of the mist system also had a noticeable effect in increasing the daily feed consumption during the hot days of summer months.

10) Provide plenty of cool water. Remember, during the high environmental temperature of summer months heat loss from the body by sensible ways (conduction, convection, and radiation) reach to a minimal, and evaporative heat loss (panting) is the major approach for birds to discharge the internal heat. It takes about 570 calories of energy to convert one gram of water from a liquid to a vapor state. This signifies the importance of availability of plenty cool water to birds during the high temperature of summer months. However, remember that mist systems should not work when the humidity of the outside air is too

high.

11) Consider providing the birds with an electrolyte and vitamin supplement through the drinking water: probably once every two weeks or at least once a month. Some producers are using the electrolytes and vitamin supplements in the water during the last week of every month during the high temperature of summer months. Considerable quantities of electrolytes are lost from the body during heat stress periods through urine due to increased water consumption. It should be noted that the water:feed intake ratio from a normal level of 2:1 (about 200 ml/hen/day) and at the zone of thermoneutrality (70° F house temperature) may be increased to 5-6:1 during the period of high environmental temperatures. Additionally, most of the B-complex vitamins are functioning as the cofactors (coenzymes) of the enzymes which are involved in energy metabolism. It can be anticipated, therefore, that the requirement for B-complex are increasing during the high environmental temperature, due to the increased rate of metabolism for mainlining the body temperature constant.

12) Recent reports also indicated that increasing the dietary level of vitamin E from a normal level to 5-10 ppm to about 50-60 ppm in laying hen diets could have a beneficial effect in alleviating the adverse effect of high environmental temperatures on performance. Scheideler (1995, BASF publication, NN 9703), reported that the adverse effect of elevated environmental temperatures of summer months on egg production performance, for the most part, was alleviated due to supplementing the layers' diet with a level of 54 ppm vitamin E. More recently, Whitehead *et al.* (1998, Southern Poultry Science Society and Southern Conference of Avian Diseases, Abstr. No. 159) reported the results of two large scale

experiments in which the effect of vitamin E in ameliorating the adverse effect of a chronic environmental temperature (30° C = 90° F) on performance of laying hens was investigated. The results of both experiments indicated that increasing the level of vitamin E above the level that normally is used in the diet, had a significant beneficial effect in ameliorating the adverse effect of a chronic temperature of 90° F on egg production. The results of a dose response study in which vitamin E was used at levels of 10, 125, 250, and 500 ppm indicated that a dietary concentration of 250 ppm vitamin E was optimum for hens giving egg production of 80.6 compared with 68.9% during the chronic heat stress period from 26 to 30 wk of age. It was also found that it is important to feed the vitamin E prior to and throughout the period of heat stress in order to keep the plasma vitamin E high to give a protection effect. The results of these studies generally indicated that increasing the level of vitamin E in the diet of laying hens prior to the period of anticipated heat stress and during the heat stress would have the potential to alleviate the adverse effect of the heat stress on performance.

13) Because high environmental temperatures have a profound effect on shell quality, it is appropriate to conclude this article by highlighting several points which should receive consideration for minimizing the adverse effect of elevated environmental temperatures on shell quality:

a) Particular attention should be given to adequacy of daily calcium intake. As was mentioned previously, by increasing the concentration of nutrients (including calcium) in the diet, the daily Ca intake should be maintained at about 4 g/hen/day, regardless of the level of daily feed consumption.

b) Every managerial effort should be made to reduce the calcium

separation along the feeding lines. Allowing the birds to clean the feeding trough daily will prevent the chance of build up fines in the feeders which may contribute to excessive calcium intake. Run the feeders with maximum possible speed. This prevents the chance of selecting particles by hens which can contribute to an imbalance intake of finished feed.

c) We have shown that if hens receive an inadequate calcium diet only for one day, their shell quality reduces significantly. The results of a more recent study refined the previous finding and indicated that if hens receive an inadequate calcium diet only during the afternoon hours, it significantly reduces shell quality.

d) You should provide 50% of the supplemental calcium in particle form. Remember that shell formation is in progress during the dark hours, while hens do not have access to feed. The particles of calcium (oyster shell or calcium chips) remain in the gizzard for a longer period and provide the hens with adequate calcium during the dark hours. The best results from oyster shell are expected to be obtained when it is substituted with 50% pulverized limestone.

e) Make sure that feeders are full during the last several hours of day light. Feeding activity is intensified during these hours in anticipation of dark hours. This ensures that the crop is full prior to the beginning of dark hours.

f) Solubility of calcium sources should receive particular consideration. We have shown that calcium sources with a solubility of 50% or greater will be satisfactory for formation of eggs with sound shells. When the suppliers of calcium sources are changed, the solubility of new sources should receive particular consideration. If shell quality is reduced during the following several weeks after changing the calcium source, then the lower solubility of the new

shipment may be a factor.

g) It is worth noting that not all the adverse effects of high environmental temperatures on shell quality are due to reducing daily calcium intake. It has been shown that when the daily calcium intake of hens exposed to high environmental temperatures are maintained equal to the control group which was maintained at a normal temperature, still, the shell quality of the former group was inferior than the control group. Respiratory alkalosis which resulted from hyperventilation (panting) also is an important phenomenon for reducing shell quality during the periods of elevated environmental temperatures. In fact, it has been shown that enrichment of the environment with CO₂ gas or providing the hens with carbonated water has the potential to improve shell quality under elevated environmental temperature. However, these approaches to date have not received application under commercial practices. Although the results of investigations on the beneficial effect of sodium bicarbonate on shell quality is equivocal, the addition of about 0.5% sodium bicarbonate to the diet during the high temperatures of summer months may have beneficial effects on shell quality. The beneficial effect of sodium bicarbonate is probably due to helping the body in maintaining the acid-base balance and may be somewhat influential in helping to provide adequate bicarbonate (CO₃⁻) for formation of the shell (CO₃Ca).

h) It is well established that trace elements in chelated forms (organic forms) can be absorbed and utilized more effectively than in inorganic forms. Both zinc and manganese are involved in the process of shell and bone formation. Zinc is a part of carbonic anhydrase, an enzyme involved in formation of bicarbonate moiety (CO₃⁻) of calcium carbonate (CO₃Ca) which makes about 98% of

the eggshell. Manganese is essential for normal process of bone and eggshell formation. Using organic chelates of zinc and manganese in the diet may have the potential to improve shell quality under elevated environmental temperature of summer months.

i) Published reports on the effect of 25-OH-D₃ and vitamin C (ascorbic acid) on shell quality are generally contradictory. Because vitamin D₃ first should be converted to 25-OH-D₃ in the liver, and then converted to 1,25(OH)₂D₃ in the kidney for becoming physiologically active, it is logical to believe that vitamin D₃ in its first hydroxylation form, i.e., 25-OH-D₃ would be more effective in absorption of calcium and its physiological involvement in shell formation than vitamin D₃. With regard to vitamin C it should be noted that laying hens have an inherent ability to synthesize an adequate level of vitamin C for fulfillment of their physiological need under normal environmental temperatures. However, during the elevated environmental temperature it appears that supplementing the diet with vitamin C may have a beneficial effect on shell quality. Apparently, this beneficial effect may be due to impairment of *de novo* (inside the body) synthesis of vitamin C during the high environmental temperature or due to increased requirement for this vitamin under elevated environmental temperature. It has been suggested that the function of vitamin C in improving shell quality is due to its involvement in hydroxylation steps of conversion of vitamin D₃ to its active form (1,25(OH)₂D₃). We were not able to demonstrate a beneficial effect from 500 IU equivalent of vitamin D₃ as 25-OH-D₃ on shell quality. Also, our data failed to demonstrate a beneficial effect from a supplemental level of 250 ppm vitamin C under elevated environmental temperatures and up to 1,000 ppm vitamin C under normal

environmental temperatures on shell quality. The effect of vitamin C and 25-OH-D₃ on shell quality needs further investigation. However, when shell quality becomes a serious problem particularly under elevated temperature of summer months, the producers may want to consider using them in the diet as the last remedy.

As can be noted from the aforementioned information, a great deal of opportunity exists to combat or at least diminish the adverse effects of elevated environmental temperatures of the summer months on production performance and egg shell quality. You should take the effect of high environmental temperature on the performance of birds seriously and make every effort to minimize the potential of losses.

*K. Keshavarz
Department of Animal Science
Cornell University*

ADVISORY COMMITTEE MEETS

The Unit of Avian Health Advisory Committee (UAHAC) met at the College of Veterinary Medicine on April 27th. The Committee consists of representatives of the industry, Department of Agriculture and Markets (DAM), College of Agriculture and Life Sciences (CALS), and College of Veterinary Medicine (CVM). The Chair-elect of the Department of Microbiology and Immunology (DMI), Dr. David Russell, welcomed the UAHAC and vowed to work closely with its members to improve service and relations for the betterment of the poultry industry.

Mr. Mark Adams and Mr. Matt Morgan, President and Executive Director of the New York Poultry Association, respectively, reported that the Avian Disease Program (ADP) budget has been included in the Governor's budget. Dr. Gray from the Department of Agriculture and Markets (DAM) and Dr. Lucio, spoke of their concerns regarding the presence of avian influenza in the live-bird market and in the water fowl population. Dr. Gray said that the DAM intention is to continue facilitating the surveillance efforts of the ADP on avian influenza (AI). In the event of detection of an AI virus, DAM will support the producers in the control of the disease. Dr. Gray announced that, regarding the New York State producers now has two options for testing. The first option is the one that has been in effect since the start of the program testing for *Salmonella enteritidis* in chick papers, one month before pullets are moved to the laying house, and testing manure and egg belts one month before the laying house is emptied. The second option places the New York egg producer at the same level as its Pennsylvania counterpart testing manure at 29 to 31 months, and at 44 to 48 months of age, with no egg belt testing.

*B. Lucio
Department of Microbiology and
Immunology
College of Veterinary Medicine
Cornell University*

NEW PERSONNEL AT THE UNIT OF AVIAN HEALTH (Department of Microbiology and Immunology, College of Veterinary Medicine)

Most of the producers that use the Poultry Diagnostic Laboratory are aware that we have been missing the excellent service provided by Dr. Jarra Jagne. Dr. Jagne was an invaluable member of the Unit of Avian Health for several years, until she joined American Selected Products early in 1999. Part of her duties was filled with a full-time technician for the rest of the year. Unfortunately for us, the technician joined the ranks of the graduate school early this year, and the Poultry Diagnostic Laboratory worked for the first 3 months of 2000 with a part-time technician. Now that the budget for the year 2000-2001 has been included in the Governor's budget, we have joined forces with Dr. Naqi, and hired Dr. Shankar Mondal, who will devote half of his time to poultry diagnosis. The other half will be devoted to our long-term surveillance and identification of infectious bronchitis virus. We are conducting interviews to hire a full-time technician that should join the program in the next month.

*B. Lucio
Department of Microbiology and
Immunology
College of Veterinary Medicine
Cornell University*

KUDOS FOR THE UNIT OF AVIAN HEALTH

(Department of Microbiology and Immunology, College of Veterinary Medicine)

In the University-wide Review Program that Cornell University is conducting to evaluate teaching, research and outreach activities, the Department of Microbiology and Immunology was praised for the quality and quantity of their research and teaching efforts. Most important for the Poultry Industry, the Department was commended for its outreach programs in Avian and Aquatic Animal Health. The Committee underlined the significance of the Avian Disease Program for the New York State poultry industry, and specifically recommended that, when replacing members of the Unit of Avian Health that retire, emphasis should be placed in finding researchers with interest in poultry diseases.

The report, presented to the Administration of the Veterinary College on May 3rd was produced by an outside Committee formed by Dr. Mary Ann Ottinger (Professor of Animal and Avian Sciences, University of Maryland), Dr. William T. Ruyechan (Professor of Microbiology, State University of New York at Buffalo), Dr. Wendy C. Brown (Professor of Veterinary Medicine, Washington State University), and Dr. Eric Pearlman (Assistant Professor of Medicine, Case Western Reserve University).

B. Lucio
Department of Microbiology and Immunology
College of Veterinary Medicine
Cornell University

TESTING FOR SALMONELLA ENTERITIDIS IS PAYING OFF IN NEW YORK STATE

The New York State Egg Quality Assurance Program (NYSEQAP), has successfully reduced egg-borne *Salmonella enteritidis* infections in humans. The NYSEQAP is a voluntary, non-disclosure program, started by the egg producers and the College of Veterinary Medicine (CVM), and later sanctioned by the Department of Agriculture and Markets (DAM) and the Department of Health (DH). At the moment, 75% of the eggs produced in New York State come from flocks that are negative for *Salmonella enteritidis*. This figure no doubt will grow larger as more producers join the program and test their flocks. New York State-produced eggs have not been implicated in *Salmonella enteritidis* outbreaks since 1996.

B. Lucio
Department of Microbiology and Immunology
College of Veterinary Medicine
Cornell University

HAVE YOU RECENTLY EXAMINED THE WATER QUALITY AND WATER MANAGEMENT ON YOUR FARM?

While water is the most important nutrient for poultry, it is the one that is most often ignored. Poultry producers are paying close attention to the daily flock mortality, egg production, feed consumption, shell quality, ventilation, temperature of the house, etc. However, usually water consumption and quality receive very little attention, and quite often are among the ignored issues on a farm. It is quite possible that problems with production performance, feed consumption, wet droppings and high mortality would be due to poor water quality on the farm and insufficient water consumption by the flocks. The objective of this article is to remind you why quality and water management on your farm should receive serious consideration in the daily managerial practices.

You should know that water makes up over 80% of the body weight of a baby chick, 55 to 60% of the body weight of an adult hen, and 66% of the egg weight. Consequently, you should not be surprised that water deprivation for a short time can have a drastic effect on productivity and health of your flocks. In fact, birds can lose over 90% of their body fat and over 50% of their body protein, and still survive. However, a 10% loss of body content results in serious

physiological disturbance and a loss of 20% in body water may lead to death.

Water has many important functions in the body. Moving the feed through the digestive system, digestion and absorption of the nutrients, lubrications of joints, maintaining the body temperature particularly during the high environmental temperature of summer months, transferring nutrients through the blood stream to different organs, removing the toxic substances (that they could be the end-product of metabolic process or could have been consumed through the feed) through the kidneys, and completion of many metabolic processes which are involved in the formation of meat and eggs, are just a few among many other important functions of water.

The potential of water deprivation exists in commercial poultry farms. Sometimes, it may take more than 24 hours for the baby chicks or poults to be delivered to the farm from a hatchery. If enough drinkers are not readily available or they are not functioning properly, then birds may be subjected to water deprivation and correcting the problem may become too late and costly. Consequently, from the first day of the growing period, proper attention should be paid to provide the birds with sufficient water and at proper time. Water deprivation due to various reasons can happen in various stages of growth and egg production. Research has shown that a water deprivation of 12 to 60 hours with turkey poults and at seven days of age, resulted in poor growth and feed consumption and these effects were significantly noticeable even when poults were five weeks old. Research with laying hens has shown that a water deprivation of 48 to 72 hours has resulted in a sharp decline in egg production and reached to a minimum in two weeks time. It took about eight weeks before egg

production was restored to a comparable level as the non-deprived-water control group. Clogging of drinkers due to the use of low quality water can happen on a commercial egg laying farm. Consequently, drinkers should be checked as often as possible to prevent these types of problems. Water restoration, after an extensive period of water deprivation (36 to 40 hours), may cause water intoxication leading to death. Young turkeys are specially susceptible to this condition.

Water deprivation and water restriction should not be confused with each other. Water deprivation happens unintentionally, while water restriction is usually done intentionally by researchers to improve the quality of litter or reduce water use in those areas of the world where water is a scarce commodity. Experiments on water restriction have been conducted on a quantitative restriction (i.e., allowing birds to drink only a part of what they can drink if they are given free choice), and on a time restriction basis (intermittent watering program). Quantitative water restriction, for the most part, has not been successful with broilers. Research has shown that a 10-15% water restriction resulted in a significant reduction of body weight, feed consumption, and feed conversion of broilers. Experiments on moderate intermittent watering programs have been successful with laying hens. It has been reported that providing the laying hens with 15-min access to water, five times per day and in an interval of 3-3.5 hours has resulted in comparable egg production to the control group which had free access to water. Drier droppings also have been determined. In this and other intermittent water experiments, basically birds were receiving enough water for optimum performance. However, overconsumption or water spillage

were prevented.

Remember, poultry are creatures of habit. When they get used to a watering system, it takes them some time to get used to another system. Research has shown that when pullets in the growing stage had access to either bell or cup-type drinkers, and then in the laying period, the drinkers were only cup-type, mortality and feed conversion were significantly higher for the pullets grown on the bell-type drinkers. Most of the mortality happened during the early part of the production cycle. Apparently the pullets which got used to bell-type drinkers during the growing period were not able to use cup-type drinkers easily during the laying period. Several years ago we also transferred 34-wk old pullets that were grown both during the growing and laying periods on nipple-type drinkers to a new house with cup-type drinkers for starting a new experiment. We lost many birds and a good number went to molt because they were not able to learn to drink from the new type drinkers. Consequently, it is important to use the same type of drinkers both during the growing and laying periods. However, we have been told by the industry that birds grown on cup-type drinkers can get more readily used to nipple-type drinkers.

The temperature of water is another important point that should be receiving consideration. When birds have a choice, they reject water that is barley warm to the human touch. With no choice, they would drink warm water, but to a limited degree. Research has shown that broilers at eight weeks of age significantly gain lower body weight when they drank from warm water at 95°F than 75°F. In some poultry houses, water lines run very close to the ceiling. If the insulation of the building is low, the water in the line may get warm during the summer. Warm water not only is a good environment for growth of bacteria,

it would not effectively reduce body temperature in summer months. You should remember that birds do not have sweat glands in the skin. At high environmental temperature of 90°F and higher, the dissipation of heat from the body surface by sensible approaches (conduction, convection and radiation) reach to a minimum. The only approach at this high environmental temperature to help maintain the body temperature is evaporation cooling. It should be remembered that it takes about 560 cal energy to convert a gram of water from liquid to a vapor state. This is a very important approach for survival. Providing the birds with cool water becomes very important for maintaining the body temperature.

Water quality is the most important factor that producers must be concerned with. Water with poor quality affects the bird's performance in two ways. First, high concentrations of bacteria or toxic elements in the water affect the normal physiological process of the body which result in inferior performance. Second, high concentrations of minerals in the water may cause either clogging of the watering system and subject the birds to water deprivation, or due to flooding of the drinkers, the litter becomes wet, which causes leg problems and breast blisters in broilers and turkeys raised on the floor. It creates managerial problems for the layers in the cages. Remember when both temperature and relative humidity are raised in a building, neither sensible, nor evaporative heat loss can take place, and mortality increases due to body heat build up.

With regard to water quality, the producers should be concerned about the following components:

Turbidity is due to the presence of material in suspension than in solution in the water. These materials can be silt, clay, algae or organic matter. Cloudy water not only is unpalatable, it causes clogging of

the watering systems. Under such condition, water should be first passed through a filter to remove particles that are in suspension.

The water that is used for poultry should be odorless, colorless, and tasteless. Taste is mostly due to the presence of salt in the water. High concentration of ferrous and manganese sulfates gives a bitter taste to water. Water with reddish to brownish color is due to the presence of iron in the water. Bluish colored water is due to the presence of copper in the water. Water with a rotten egg odor is due to the presence of hydrogen sulfide in the water.

Total dissolve solids is an expression of total ions (both cations and anions) in dissolve form in the water. A clear water does not necessarily mean that it is safe for poultry. It might have high concentrations of elements in solution in the water.

Hardness is an expression of total calcium and magnesium content of the water expressed as calcium carbonate equivalent. Water with high concentration of calcium and magnesium is not suitable for poultry. Calcium and magnesium cause formation of scales in different parts of the watering systems and cause clogging of the pipes and drinkers. Such water should be treated properly for removing these elements prior to use.

pH is an expression of acidity or alkalinity of water. Water with a pH of 7 is neutral, below 7 is acidic and above 7 is alkaline. Water with low pH is due to the presence of dissolve CO_2 in the water or water which contains mineral acids (hydrochloric, sulfuric, and nitric acids). High pH is due to the presence of high levels of calcium and magnesium in the water. A water with pH in the range of 6.5-7.5 is optimum for poultry. Water with low pH makes the water less palatable and corrodes metal parts of the watering system. A high concentration of sulfate in the water is laxative and causes loose

droppings. Also, high concentrations of sulfate, chloride, and phosphate in the water can adversely affect shell quality.

The concentration of nitrate and nitrite in water should receive attention. The origin of nitrate can be organic due to contamination of water with fertilizers or water passing through areas that were spread with manure, or inorganic due to water dissolving rocks which contain nitrate. Nitrate as such is not toxic, but due to the effect of microorganisms in the intestinal tract, it is converted to nitrite which is a very toxic substance. When nitrate enters the blood stream it makes the hemoglobin incapable of releasing oxygen. Hydrogen sulfide (SH_2) which sometimes is referred to as sulfur water, is a gas present in water with an offensive "rotten egg" odor. Presence of certain bacteria in the water reduces the sulfate and contributes to formation of hydrogen sulfide. When hydrogen sulfide combines with iron, iron sulfide (black water) is formed. The presence of sulfur in the water has an inconsequential effect on sulfur amino acid requirement of poultry. Chlorination of water is effective to kill the bacteria and prevent formation of hydrogen sulfide. High concentration of sodium or chloride in the water increases water consumption and leads to wet litter.

When water is drawn to the surface, iron occurs in ferrous soluble form. However, due to exposure to air or dissolved oxygen, it is oxidized to insoluble ferric ion which then combines with free hydroxyl ion (OH) and makes an insoluble gelatinous compound (ferric hydroxide) more commonly known as red or rusty water. These gelatinous type compounds also contribute to clogging of the watering system. Increasing the laying house temperature would increase the problem associated with iron loving bacteria. Presence of high concentration of manganese in

the water gives a bitter taste to the water. Also, water may have high concentration of toxic elements such as arsenic, lead, selenium, and vanadium, among others. High concentration of these toxic elements in the water affects normal physiological performance and contributes to inferior performance.

Water for poultry should have no microbial contamination. However, different kinds of microbial contamination may happen particularly when water passes through the agricultural land which is spread with manure. It is important that water be checked regularly for the possibility of microbial contamination. Chlorination of water is the best approach to solve the problem. However, adequate contact time between bacteria and chlorine should be allowed for chlorine to be effective. A contact time of about 20 min. should be considered and the concentration of chlorine at the proportioner site should be about 2-3 ppm. A residual chlorine (chlorine in the drinkers in front of the bird) of about 0.5 ppm is an indication that chlorine has been used effectively. Depending on the level of bacterial contamination a higher level of chlorine may be needed. Chlorine is an oxidizing agent. Due to chlorination hydrogen and iron sulfides are converted to sulfate which is relatively less harmful. Control of hard water can be done by various approaches including the use of water softeners (which exchange calcium and magnesium of water, the main reasons for hard water, with sodium), or use of polyphosphate compounds which keep calcium and magnesium in solution, thus preventing formation of scales in watering systems. High and low water pH can be corrected by using proper compounds including soda ash or food grade phosphoric acid to water, respectively, among other approaches. Water from a pond may

be contaminated with algae, which can be killed by spraying copper sulfate on the water. Research has shown that the presence of 48 ppm copper sulfate in the water does not produce an adverse effect on birds. When water has a high concentration of sulfate, nitrate, and chloride, the water source should be changed. Although these impurities can be removed from the water, usually treatment is expensive. When microbial or water quality are suspected on the farm, the matter should be consulted with water quality experts.

Regular measurement of water consumption should be an important part of flock management. Every house should be equipped with a reliable water meter and checking the water meter should be the first job of the house manager when he/she enters the building in the morning. For large houses, a meter should be provided at the beginning of each row. Pressure systems should be checked regularly to make sure that correct pressure is used. Changes in the daily water consumption can be even more important than the daily total water consumption. There might be a problem with the delivery system, a problem in feed mixing, an impending disease or water leak.

Live viral or bacterial vaccines may be administered through the drinking water. These should be added to water free of drugs and disinfectants. Most drug doses are calculated for birds which are housed at 70°F. When water consumption is increased due to a rise in house temperature (such as summer months), care must be taken not to overdose the birds. By the same token, there is a danger of underdosing the birds in cool weather when water consumption is reduced. For birds raised on the floor, the drinkers should be leveled with the birds' back to prevent regurgitation of feed to the drinkers and to reduce water spillage. Nipple

drinkers should be kept slightly higher than the bird's head.

The results of field studies have shown that in some poultry farms where achievement of optimum performance has not been possible and wet litter continues to be a problem, the reason has been or closely associated with use of water with poor quality. It should be noted that the concentration of organic and inorganic elements in waters do not remain constant in surface or ground water. Consequently, water analysis, at least on an every six months basis, can be a proper managerial practice. Unfortunately, the area of water quality has not received sufficient consideration and information on maximum safe levels of various elements in water for poultry is very scarce. The information of Table 1 is from a paper which appeared in *Feedstuffs* magazine (December 1995) based on a talk presented by Drs. Eva Wallner-Pendleton and Sheila Scheideler at the 1995 Iowa Poultry Symposium.

It has been assumed that at normal temperatures of about 65-75°F, a bird consumes twice as much water as feed on a weight basis. However, this is just an approximation. In fact, the daily water requirement does not remain constant and is influenced by many factors including age, environmental temperature, rate of growth or egg production, state of health, composition of diet, type of diet (mash vs pellets), percentage of protein and salt in the diet, among others. The data of Table 2 is based on NRC (1994) recommendation for birds kept at 70°F (21°C), except for brooding chicks and poults. A laying hen may consume 150 to 300 ml water per day (40 to 80 gallons/1000 hens/day) based on environmental temperatures and many other factors. Research has shown that the daily water consumption is greater with trough than nipple-type drinkers. The data of Table 3 is a guideline or suitability of water for poultry based on recommendation of NRC (1974).

In summary, both quality and water management should receive serious consideration in daily managerial practices. High levels of nitrate and bacteria can affect performance of birds. High concentration of calcium, magnesium and iron salts in the water can cause formation of scales and slugs and contribute to clogging of the watering systems. With margins being so small and competition so keen, there is no room for underestimating the significance of this most important nutrient on your farm.

*K. Keshavarz
Department of Animal Science
Cornell University*

Table 1. Drinking water quality standards for poultry

Contaminant or characteristic	Level considered average	Maximum acceptable level	Remarks
Bacteria			
Total bacteria	0/ml	100/ml	0/ml is desirable
Coliform bacteria	0/ml	50/ml	0/ml is desirable
Nitrogen compounds			
Nitrate	10 mg/l	25 mg/l	Levels from 3 to 20 mg/l may affect performance.
Nitrate	0.4 mg/l	4 mg/l	
Acidity & hardness			
pH	6.8-7.5	—	a pH of less than 6.0 is not desirable. Levels below 6.3 may degrade performance.
Total hardness	60-180	—	Hardness levels less than 60 are unusually soft, those above 180, very hard.
Naturally occurring chemicals			
Calcium	60 mg/l		
Chloride	14 mg/l	250 mg/l	Levels as low as 14 mg/l may be detrimental if the sodium level is higher than 50 mg/l.
Copper	0.002 mg/l	0.6 mg/l	Higher levels produce a bitter flavor.
Iron	0.2 mg/l	0.3 mg/l	Higher levels produce a bad odor and taste.
Lead	—	0.02 mg/l	Higher levels are toxic.
Magnesium	14 mg/l	125 mg/l	Higher levels have a laxative effect. Levels greater than 50 mg/l may affect performance if the sulfate level is high.
Sodium	32 mg/l	—	Levels above 50 mg/l may affect performance if the sulfate or chloride level is to high.
Sulfate	125 mg/l	250 mg/l	Higher levels have a laxative effect. Levels above 50 mg/l may affect performance if magnesium and chloride levels are high.
Zinc	—	1.50 mg/l	Higher levels are toxic.

Schwartz, D.L., "Water Quality", VSE 81c., Pennsylvania State University; and R Waggoner, R. Good, and R. Good, "Water Poultry Performance", in Proceedings AVMA Annual Conference, July 1984.

Table 2. Water consumption by chickens and turkeys of different ages

Age (wk)	Broiler Chickens (ml/bird/week) ^a	White Leghorn Pullets (ml/bird/wk)	Brown Egg-Laying Pullets (ml/bird/wk) ^a	Large White Turkeys (ml/bird/week) ^{a,b}	
				Males	Females
1	225	200	200	385	385
2	480	300	400	750	690
3	725	—	—	1,135	930
4	1,000	500	700	1,650	1,274
5	1,250	—	—	2,240	1,750
6	1,500	700	800	2,870	2,150
7	1,750	—	—	3,460	2,640
8	2,000	800	900	4,020	3,180
9	—	—	—	4,670	3,900
10	—	900	1,000	5,345	4,400
11	—	—	—	5,850	4,620
12	—	1,000	1,100	6,200	4,660
13	—	—	—	6,480	4,680
14	—	1,100	1,100	6,680	4,700
15	—	—	—	6,800	4,720
16	—	1,200	1,200	6,920	4,740
17	—	—	—	6,960	4,760
18	—	1,300	1,300	7,000	—
19	—	—	—	7,020	—
20	—	1,600	1,500	7,040	—

NOTE: Dash indicates that information is not available.

^aVaries considerably depending on ambient temperature, diet consumption, rates of growth or egg production, and type of equipment used. The data presented apply under moderate (20° to 25°C) ambient temperature.

^bBased on data obtained from commercial turkey production units.

Table 3. Guidelines for poultry for the suitability of water with different concentrations of total dissolved solids (TDS)

TDS (ppm)	Comments
Less than 1,000	These waters should present no serious burden to any class of poultry.
1,000 - 2,000	These waters should be satisfactory for all classes of poultry. They may cause watery droppings (especially at the higher levels) but should not affect health or performance.
3,000 - 4,999	These are poor waters for poultry, often causing watery droppings, increased mortality, and decreased growth (especially in turkeys).
5,000 - 6,999	These are not acceptable waters for poultry and almost always cause some type of problem, especially at the upper limits, where decreased growth and production or increased mortality probably will occur.
7,000 - 10,000	These waters are unfit for poultry but may be suitable for other livestock.
More than 10,000	These waters should not be used for any livestock or poultry.

Source: National Research Council. 1974. Nutrients and Toxic Substances in Water for Livestock and Poultry. Washington, D.C.: National Academy of Sciences.

DEVELOPMENTS IN RESEARCH

The following are extracts of some of the papers presented at the 21st Annual Meeting of the Southern Poultry Society during January 17-20, 2000, in Atlanta, GA.

* Egg losses through the cage because of shell quality problems can be substantial (6 to 16%) in mature flocks. Patterson and Acar (Penn State University) conducted an experiment with objectives: 1) document egg losses through the cage and in shell quality among first cycle hens, and 2) compare the ability of dietary intervention programs to mitigate these losses. Two commercial strains (n = 384) representing egg strains were compared for eleven 28-day periods. When shell quality had diminished by the end of the seventh period, four dietary intervention treatments were initiated: control (C), oyster shell + vitamin D₃ (ShD), calcium chips + vitamin D₃ (ChD), and Alltech Eggshell-49 (ES49). Egg losses as a percentage of hen-day egg production remained at less than 1% during the first 6 periods. At the end of periods 7 and 8 losses exceeded 1% and increased to more than 2% by periods 10 and 11. Strain significantly impacts egg production, eggs per hen housed, feed consumption and feed conversion, however, dietary treatments had no effect on these parameters or body weight. While repeatable and significant strain differences in egg specific gravity, egg weight, shell weight, and thickness were observed throughout the entire study, dietary treatments had no consistent impact on these parameters. The one exception was egg weight which was significantly greater in periods 8 - 11 among birds fed the ES49. However, the same hens had significantly greater egg weight before the dietary treatments

were initiated. The investigators concluded that under the conditions of their experiment, dietary intervention strategies aimed at improving the egg shell quality of graded eggs showed no consistent improvement compared to a well balanced control diet.

* Bryant and Roland (Auburn University), reported the result of an experiment which was conducted to determine whether the use of Tylan (an antibiotic approved for the control and treatment of mycoplasmosis in poultry) would have any effect in improving the feed efficiency in layers. The experiment consisted of a 3 X 3 factorial design with three levels of protein (15.6, 16.7, and 18.1%) and three levels of Tylan (0, 25, and 50 g/ton of feed). The Hyline W36 were fed the experimental diets for 20 wk. Increasing the protein level from 15.6 to 18.1% resulted in a significant improvement in egg production, feed consumption, egg weight, and feed efficiency. However, Tylan did not have a significant effect on these traits. Although not significant, Tylan numerically increased egg production, egg weight and reduced feed consumption. The numerical cumulative effect of Tylan on these traits, resulted in a significant effect of Tylan in increasing feed efficiency, after an initial adjustment period of 5 wk. The investigators concluded that supplemental Tylan may have a significant effect in improving feed efficiency of layers.

* Harms and Russell (University of Florida) conducted an experiment to determine the valine requirement of laying hens. A corn-soybean diet was supplemented with valine to provide diets with total valine content in the range of 0.525% to 0.7%. A positive control corn-soybean diet with 0.765% valine and only methionine supplementation was used as the positive control. Egg production was increased by the addition of valine up to 0.63%, and egg weight was increased by the

addition of valine up to 0.655%. The results of the broken-line regression indicated a daily valine requirement of 592.5, 697.7, and 619 mg/hen/day valine for egg production, egg weight, and feed conversion, respectively. This was equal to a requirement of 13.1 mg per gram egg content.

* Berry and Lui (Auburn University) conducted an experiment to determine whether the combination of Bio-Mos and Eggshell-49 (both products of Alltech, Inc.) would affect egg production, shell quality, and bone strength in broiler breeder hens during a second laying cycle. Four hundred 65 wk of age broiler breeder hens were subjected to molting by reduction of daylight and feed withdrawal until 25% body weight reduction. Thereafter, half of the hens in their experiment were fed a control breeder diet (control group), while the second half were fed a combination of 1 lb/ton Bio-Mos and 1 lb/ton Eggshell-49 for one wk (treated group). Diets were fed at the rate of 30 lbs/100 birds/day (136 g/hen/day). Following the return of birds to egg production, production records were kept for 12 wk. Shell quality was measured on a weekly basis, and femurs from hens in each group were analyzed for wet and dry weight, breaking strength, and ash weight. Hens in the treated group had significantly greater body weight at the end of the experiment. Egg production increased faster in the treated group after feeding resumed. Although egg production was not different between the two groups at the peak, egg production remained higher in the treated group after peak. The treated group produced on average 6 eggs per hen greater than the control group. Egg weight, specific gravity, shell weight, and shell weight per unit surface area were not different among the two groups. Femur dry weight and ash weight tended to be reduced in the treated

group, while bone breaking strength was significantly lower in the treated group. These results indicated that the inclusion of Bio-Mos and Eggshell-49 in the diet of molted breeder hens supported increased egg production and improved feed conversion without degradation of shell quality. However, increased egg production may have led to reduced bone strength through changes in bone structure and depletion of bone minerals.

* Owens and Ledoux (University of Missouri) reported the results of an experiment which was conducted to determine the effect of 25-OH-D₃ on performance and bone mineralization of turkey poults. The experimental diets were used during day-old up to 21 days of age. The diets consisted of a positive control with 1.2% Ca, 0.6% available phosphorus (AP), and 1,100 ICU vitamin D₃ (diet 1), a basal diet containing 1% Ca, 0.3% AP, and supplemented with 1,100 ICU vitamin D₃ (diet 2), the basal diet supplemented with 3,650 ICU vitamin D₃ (diet 3), the basal diet supplemented with 20, 40, 60, 80, and 100 mg 25-OH-D₃/kg diet (diets 4 to 8). In comparison to the positive control, all the diets resulted in lower body weight gain, feed consumption, tibia ash weight, and bone strength. There were no significant differences between the two vitamin D₃ levels with regards to body weight gain, feed intake, bone ash weight, and bone strength. However, percentage bone ash was higher in poults fed 3,650 ICU vitamin D₃ than those fed 1,100 ICU vitamin D₃. Also, compared with poults fed 20 mg per ton 25-OH-D₃, poults fed 40 to 100 mg 25-OH-D₃, gained more weight and had stronger bones. The results suggested that 25-OH-D₃ may be more effective than vitamin D₃ in promoting phosphorus utilization.

* Johnson and Southern (Louisiana State University) conducted two experiments with young chicks to determine the contribution of

phytase to total metabolizable energy content of the diet. Using adjusted gain and feed conversion ratio from both experiments, they concluded that 600 units phytase from Natuphos provide 45.7 kcal ME/kg diet.

* Maurice *et al.* (Clemson University) reported the results of an experiment which was conducted to determine the ability of broiler chicks in utilizing phytate phosphorus. The chicks were fed a starter diet during the first 3 wk and a grower diet during the second 3 wk. Fecal samples were collected throughout the experiment. The phytate phosphorus content of feed and fecal samples were determined. The results indicated that phytate phosphorus retention during 0 to 3 wk was 39.3% and during 3 to 6 wk was 60.3%. The investigators felt that the enhanced utilization with age may have been due to age effect or changes in the dietary level of calcium. Also, they concluded that broiler chicks can utilize natural phytate and the extent of utilization depends on age and dietary factors.

* Si *et al.* (University of Arkansas) conducted an experiment with broilers to determine whether the use of low-protein amino-acid supplemented diets can support a similar performance as diets containing higher levels of protein. Diets were formulated to satisfy 107.5% of the NRC (1994) amino acid recommendation. With reducing the dietary protein, the levels of methionine, threonine, lysine, valine, isoleucine, arginine, phenylalanine, and tryptophan, in sequence became limiting. Consequently, the eight diets were formulated to contain sufficient levels of these amino acids. The experimental diets were used from 0 to 3 wk of age. Reducing the dietary protein below 20% while maintaining the level of essential amino acids adequate, resulted in a significant reduction of body weight and feed conversion. Protein content of the carcass was reduced, while

the fat content of the carcass increased with reducing the dietary level of protein. Feather content was not affected until the protein content was reduced to below 18%.

* Yan *et al.* (University of Arkansas) reported the results of an experiment which was conducted to determine the ability of young turkeys in utilizing phosphorus from high-available-P corn (HAPC) as compared to normal corn (NC) with and without microbial phytase (Natuphos, BASF) in the diet. The HAPC is a mutation of normal corn, containing 0.27% total phosphorus which from this 0.17% is available phosphorus. The NC has a similar level of total phosphorus as the HAPC, but contains only 0.03% available phosphorus. Experimental diets were formulated to contain a range of 0.12% up to 0.72% available phosphorus with NC, and diets with a range of an available phosphorus content of 0.18% to 0.72% with HAPC. Phytase was used at 1000 units/kg diet. The period of the experiment was from 0 to 18 days of age. Body weight, feed conversion, and mortality were optimized with available phosphorus levels far less than 0.6% suggested by NRC (1994), with the greatest phosphorus demand for tibia ash. With both sources of corn, tibia ash was optimized with 0.5 to 0.55% available phosphorus. When phytase was added, the available phosphorus need was reduced to 0.35%. Birds fed this level of available phosphorus had considerably lower fecal phosphorus than those fed 0.6% available phosphorus, a level more similar to typical commercial turkey diets. The investigators concluded that the use of HAPC diet with phytase supplementation can markedly reduce fecal phosphorus without loss of performance in young growing turkeys.

* Cantor *et al.* (University of Kentucky) conducted an experiment to determine the effect of using low-protein, amino acid-supplemented

diets on performance of broilers. The experiment consisted of grower (day 18 to 35) and finisher periods (day 35 to 42). The protein levels in the grower and finisher diets, respectively were: diet A, 23 and 22.5%; diet B, 20.8 and 20%; diet C, 18.5 and 17.5%, and diet D, 16.3 and 15%. The lowest protein diets were supplemented with lysine, arginine, methionine, threonine, tryptophan, isoleucine, and valine. Decreasing dietary protein resulted in linear decrease in body weight and feed intake, and feed efficiency. There were no differences for these variables in treatments A and B. Decreasing protein level from diet A to diet D resulted in reducing feed efficiency by 7.2% and decreasing final body weight by 9.8%. However, reducing dietary protein from level A to level C resulted in reducing feed efficiency and body weight by 2.1 and 4.7%, respectively.

*K. Keshavarz
Department of Animal Science
Cornell University*



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