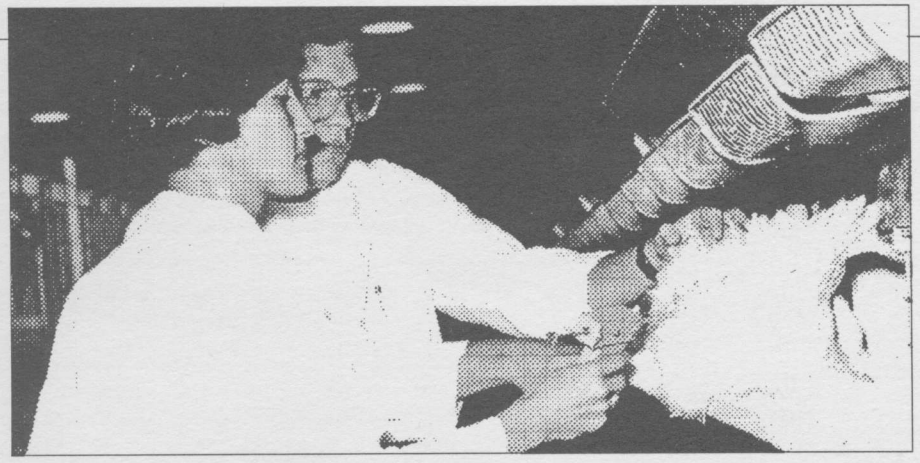

RESEARCH UPDATE 1991

POULTRY

Feeding Low Levels of Phosphorus to Layers Increases the Risk of Bone and Kidney Disorders

Some egg producers tend to feed marginal or deficient levels of phosphorous (P) because P sources are expensive and an improvement in egg shell quality is occasionally observed when dietary P levels are lowered. However, a recent AAES study showed that hens excreted abnormally high amounts of calcium through the urine when they were fed layer diets containing low levels of phosphorus. This reaction is not economical from the layer nutrition viewpoint, and the associated urinary condition may adversely affect health of the birds.

The purpose of the study was to determine the influence of various levels of dietary calcium (4 and 6 percent) and phosphorus (0.3 and 0.6 percent total) on plasma ionic calcium (Ca^{++}) and inorganic phosphorus (P_i) and on urinary calcium. Two hundred and forty Hyline W36 hens were equally allocated to four layer diets containing different combinations of calcium and phosphorus, as shown in the table. Urine and blood were collected for analysis from the hens after 3 and 10 days of feeding the treatment diets.

Influence of Different Dietary P and Ca Levels on Urinary Ca, Plasma Ionic Ca (Ca^{++}), and Inorganic P (P_i) in Commercial Layers

Samples	Dietary levels of Ca and total P			
	4% Ca, 0.6% P	4% Ca, 0.3% P	6% Ca, 0.6% P	6% Ca, 0.3% P
Third day sampling				
Plasma Ca^{++} (mg/dL)	6.2	6.3	6.3	6.6
Plasma P_i (mg/dL)	4.8	3.3	4.7	2.4
Urinary Ca (mg/dL)	48.7	140.2	64.9	214.4
Tenth day sampling				
Plasma Ca^{++} (mg/dL)	5.8	6.4	6.4	6.5
Plasma P_i (mg/dL)	6.7	4.1	7.1	3.8
Urinary Ca (mg/dL)	41.6	98.8	67.4	154.0

At the 4 percent dietary calcium level, the hens fed diets containing low phosphorus (0.3 percent total) had lower plasma P_i, higher plasma Ca^{++}, and three-fold higher urinary concentrations than the ones fed diets containing 0.6 percent total phosphorus. The detrimental effect of feeding low levels of phosphorus was further enhanced when the diet contained excess amounts of calcium. The increase in urinary Ca excretion caused by lowering dietary phosphorus was five-fold when the diet contained 6 percent calcium.

The excretion of high amounts of calcium through urine may cause hens to develop either or both of the following health problems: (1) If the calcium in the urine comes from bone, prolonged calcium excretion may deplete bones and cause cage layer fatigue. (2) The excess calcium in the urine may react with uric acid present in the urine to form solid urates which can block urine flow and cause damage to kidneys.

In the field, if hens are predisposed to any low dietary phosphorus-induced stress, they are very susceptible to other pathogenic agents present in the environment, which complicates the diagnosis of the origin of the problem. Although feed costs will increase by adding a sufficient margin of safety in dietary phosphorus content, the costs can be offset by the savings gained by improved flock performance and reduced mortality.

K.S. Rao and D.A. Roland, Sr.

ALABAMA AGRICULTURAL EXPERIMENT STATION AUBURN UNIVERSITY
LOWELL T. FROBISH, DIRECTOR AUBURN UNIVERSITY, ALABAMA

Synthetic Vitamin D_3 Metabolites Improve Bone Strength In Aged Layers

Dietary vitamin D_3 is converted in the liver and kidney to an active hormonal form of the vitamin, 1,25-dihydroxyvitamin D_3. This metabolite of vitamin D_3 plays a major role in calcium and phosphorus metabolism in the body, stimulating the release of these two minerals for building bone and egg shell. The natural decline in egg shell quality and bone strength with age is believed to be the result of a decrease in the bird's ability to metabolize vitamin D_3.

Based on this theory, experiments were conducted at Auburn using aged laying hens (70 weeks of age) to determine if vitamin D_3 metabolites, namely 1,25-dihydroxyvitamin D_3 and l-alpha-hydroxyvitamin D_3, when supplemented in the diet would improve bone strength and egg shell quality.

In the first experiment, supplementation with either metabolite caused an increase in bone weight, but no improvement was evident in bone breaking strength or in egg shell quality. In the second experiment, three levels of 1,25-$(OH)_2$ D_3 were fed at each of four different levels of vitamin D_3. Results showed that improved bone weight, bone breaking strength, and egg shell quality resulted from adding the metabolite to a vitamin D_3-deficient diet, see table. When birds were fed a diet containing 1500 ICU D_3/kg supplemented with 1,25-$(OH)_2$ D_3, the response was not as pronounced.

The Effects of Dietary Supplementation of 1,25 $(OH)_2$ D_3 to a Vitamin D_3 Deficient Diet on Bone and Egg Shell Strength

1,25 $(OH)_2$ D_3 (µg/kg)	Bone weight (g)	Bone breaking strength (kgF)	Egg specific gravity	Shell weight (g)	Egg weight (g)
0.0	5.1	5.8	1.0732	5.05	63.9
.5	6.0	7.6	1.0773	5.51	65.4
1.0	5.9	7.4	1.0782	5.52	64.8

Egg specific gravity was improved with the metabolite; however, an observed decrease in egg weight would account, in part, for this improvement. Shell weight, percent shell, and egg breaking strength were not significantly improved by feeding the metabolite. However, bone breaking strength and bone weight were significantly increased by adding the metabolite when sufficient vitamin D_3 was fed.

These results indicate that, in the aged hen, vitamin D_3 is sufficiently metabolized to maintain egg shell quality. However, the increases in bone strength due to supplemental 1,25-$(OH)_2$ D_3 suggests that vitamin D_3 is not sufficiently metabolized to the active form [1,25-$(OH)_2$ D_3] in the blood to maintain bone strength.

T.J. Frost and D.A. Roland, Sr.

New Vaccine Tested for Control of Reovirus Diseases in Broilers

Avian reoviruses, prevalent in poultry-producing regions worldwide, cause poor digestion and absorption of nutrients.

Control of reoviruses through immunization of broiler breeder stocks was thought to be effective in the past. However, this immunization method has proven ineffective in recent years, particularly in broiler males reared for an extended growout period.

Early immunization of these birds with a live virus can induce extended resistance to reovirus infection. Unfortunately, live highly attenuated vaccines given at 1 day of age in conjunction with Marek's disease (MD) vaccine interferes with the replication of MD vaccine causing increased MD condemnations. Less attenuated reovirus vaccines administered through drinking water (DW) routes are generally too reactive to use in broilers less than 2 weeks of age.

These problems point to the need for a reovaccine which is safe, not reactive, does not interfere with other vaccines, and is effective in young chicks. AAES research evaluated a new reovirus vaccine for vaccination of chickens between 1 and 7 days of age. This product, Enterovax®, is a modified mild-reacting cell cultured cloned reovirus vaccine produced by Schering-Plough Animal Health, Kenilworth, New Jersey.

In the first trial, day-old specific pathogen free (SPF) broilers were given this reovirus vaccine mixed with Newcastle disease (ND) and infectious bronchitis (IB) vaccines by coarse spray (CS) route. Infectious bursal disease (IBD) virus vaccine was also given by subcutaneous route (SQ). At 2 weeks of age, chicks were challenged with reovirus. Results showed that vaccinated chicks had resistance to infection as measured by the absence of gross lesions and high body weights at 42 days of age. Antibody titers against IBDV, NDV, and IBV showed no interference among the four vaccine viruses.

Trial 2 was done with commercial broilers having maternal antibody to reovirus. Birds were vaccinated at 1 day of age with reovirus by CS or SQ routes. Some of the

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New Vaccine, continued

Enterovax-vaccinated birds were also given MD vaccine by SQ or MD vaccine alone. At 2 weeks, birds were either challenged with virulent MD or reovirus. Results showed that vaccinated challenged birds had significant resistance to reovirus challenge at 7 weeks of age. MD-challenge results showed no interference with the two vaccines.

A third trial was done in commercial broilers with maternal immunity that had been vaccinated under commercial conditions. Birds were either vaccinated in the company's hatchery at 1 day of age by CS mixed with ND-IBV vaccines and/or 7 days of age in the broiler house. Some of the 7-day-old vaccinates received reovirus vaccine by CS and others by DW. Birds were challenged with reovirus at 21 days of age.

Birds vaccinated at 1 day of age by CS, at 1 and 7 days by CS, at 7 days by CS, or at 1 day by CS and 7 days by DW had protection against challenge at 6 weeks of age. However, a single vaccination at 1 day of age was inferior to the other three vaccination regimes. There were no differences in results between the three 7-day vaccine regimes, indicating that a single vaccination at 7 days by CS or DW is sufficient to induce resistance to infection.

Results indicate that Enterovax given by CS or DW route between 1 and 7 days of age will effectively induce immunity in broilers with maternal antibodies and will not interfere with other vaccines given simultaneously.

J.J. Giambrone

Intestinal Immunization Necessary for Effective Control of *Salmonella*

The contamination of poultry products with *Salmonella enteritidis* is an international public health problem in the poultry industry. Many procedures have been used with variable degrees of success in attempts to lower the incidence of contamination, but the problem still persists.

It is reasonable to assume that vaccination would limit or lower the rate of *S. enteritidis* contamination in poultry. A vaccine developed at the AAES induced a good antibody re-

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Composting Offers An Alternative for Disposal of Dead Birds

Mortality is a normal component of broiler production. For a flock of 100,000 broilers grown to 49 days of age and averaging 0.1 percent daily mortality (4.9 percent total mortality), approximately 5 tons of dead birds require disposal.

Identification of alternative methods for the disposal of mortalities has been recognized as a priority by the poultry industry due to newly imposed local, State, and federal environmental regulations.

Presently, burial pits are commonly used for dead bird disposal on poultry farms; however, the persistence of residues in these types of pits after years of use and the potential for ground water contamination are emerging reasons for considering alternative methods of disposal. Incineration is one of the biologically safest methods of disposal; however, it is slow, expensive, and may generate air pollution.

Composting, a natural process by which organic waste material is broken down by naturally occurring microorganisms into a more useful end product, is an environmentally and biologically safe alternative for the disposal of poultry farm mortalities. It is critical that the composting process results in inactivation of pathogenic (avian and human) microorganisms before compost is applied to land. The elimination of pathogens is brought about by thermal inactivation through heat generated during a normal composting cycle.

A commercial on-farm composter was investigated by AAES researchers to determine changes in microbial populations, temperature, and moisture over a typical composting cycle. During composting, the population of total aerobic bacteria remained relatively constant throughout primary and secondary composting. High levels of enteric (coliform) bacteria declined only slightly during primary composting, but were reduced to nondetectable levels once the compost was aerated by transfer to a secondary composting bin.

Temperatures in the primary bin increased within 3-5 days to 110-120° F and remained steady until the material was transferred 7-8 days later to the secondary bin. Temperatures in the secondary bin quickly achieved 140-150° F and remained steady during 25 days of composting. Moisture levels varied from 25 to 45 percent.

Results of this study indicate that coliform bacteria were effectively inactivated during composting, indicating that enteric pathogens such as *Salmonella* would be inactivated. Results further indicate that aeration due to transfer of compost from the primary to secondary bin is critical for temperature generation and the resultant thermal inactivation of enteric bacteria.

Based on this evaluation, composting appears to be an environmentally and microbiologically sound method for the disposal of dead poultry.

D.E. Conner, J.P. Blake, and J.O. Donald

Intestinal Immunization, continued

sponse in the circulation of chickens against *S. enteritidis*.

Challenge of vaccinated chickens with live, virulent *Salmonella* revealed that the chickens were resistant to visceral infection but *S. enteritidis* was still able to colonize parts of the intestine. This indicated that *Salmonella* contamination was still possible in spite of the good immune response.

It was concluded that specific immunization of the intestinal tract of chickens is necessary to effectively control *Salmonella* contamination. A vaccine is being developed to induce a secretory immune response in the digestive tract of chickens.

E.C. Mora

Light:Dark Ratios Can be Adjusted for Broiler Breeder Production

Rearing broiler breeder replacements on a daily light regime of 8 hours light (L) and 16 hours dark (D) from 2 to 20 weeks of age will effectively stimulate onset of egg production. However, reducing the hours of light would help to reduce energy requirements for lighting and thus lower the cost of rearing replacements. An AAES study was conducted to determine if different periods of daily light could be used without detrimental effects on broiler breeder replacements.

After 1 week in which all birds were subjected to 23 hours L and 1 hour D daily, these four light:dark ratios were compared:

4 hours L:20 hours D
6 hours L:18 hours D
8 hours L:16 hours D
10 hours L:14 hours D

Each treatment involved 300 broiler breeder females and 40 males which remained on the light treatments (with all other management practices standard for all) until 20 weeks old. They were then moved to a breeder house and subjected to a standard 15 hours L:9 hours D regime for the next 30 weeks. Production was evaluated for the 30-week period to determine effects of light treatment during rearing on reproductive performance of the adult birds.

Females grown with 4 hours L:20 hours D daily matured 11 days later than those raised on 6, 8, or 10 hours of light. As a result, the 4-hour light females reached peak production later than the others, had lower production during weeks 23-30, and had lower total production to 50 weeks of age. In contrast, there was no difference in production to 50 weeks among those raised on 6, 8, or 10 hours of light daily, as listed below:

Light ratio	*Eggs to 50 weeks*
4 hours L:20 hours D	123
6 hours L:18 hours D	132
8 hours L:16 hours D	131
10 hours L:14 hours D	131

Hen-day egg production was 63.9, 68.4, 67.3, and 67.0 percent, respectively, for the 4, 6, 8, and 10 hours daily light. Those raised on 6, 8, and 10 hours of light peaked in production (reached approximately 80 percent lay) by 29 weeks of age. There was no difference in average egg weight, egg specific gravity, and body weight of females as a result of light regimes.

In males, sexual maturity was delayed for 7 days by the 4-hour daily light regime. There were no differences among the 6, 8, and 10 hours daily light groups. Body weight, semen concentration, and semen volume were unaffected by lighting.

Since the results show no differences among the lighting regimes using 6, 8, and 10 hours of light per day, regimes other than the standard 8 hours L:16 hours D can be used for rearing broiler breeder replacements.

G.R. McDaniel

Recycled Paper Chips Suitable as Broiler Litter

Pine shavings are the principal material currently used as broiler litter in the Southeast. However, the recent development of the composite board industry has resulted in a decrease in the availability and an increase in the cost of pine shavings. This situation, coupled with the continued expansion of the broiler industry, has resulted in an increased demand for alternative litter materials.

Many types of materials have been investigated for use as poultry litter but, to date, none has been adopted for widespread use by the broiler industry. Litter materials derived from waste newspapers offer an attractive alternative to pine shavings since waste newspapers are widely available and relatively inexpensive. Furthermore, newspapers currently take up a large percentage of available landfill space and, hence, there is political and economic pressure to recycle this material.

When used as broiler litter, materials derived from recycled paper products have been observed to have a higher moisture content and result in a greater degree of litter caking than wood shavings. However, by processing recycled newspaper into a chip form, it may be possible to create a litter material which will be suitable for use by the broiler industry.

In a recent AAES study, ultra-absorbent recycled paper chips (Advanced Material Technology, Inc., Ashville, Alabama), formed by completely reprocessing waste newspapers, were tested at the Poultry Research Unit to determine their suitability for use as litter material for growing broilers. Litter, growth, and processing parameters were determined while using paper chips or pine shavings for rearing broilers.

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Recycled Paper Chips, continued

In the first trial, broilers were grown to 51 days of age in pens prepared with 4 inches of either clean paper chips or pine shavings. In the second trial, 1 inch of clean paper chips or pine shavings was added to stirred litter remaining in each pen from the first trial and groups of broilers were grown to 50 days of age.

Production parameters such as body weight, feed consumption and conversion, dressing percentage, and the occurrences of mortality, breast blisters, and leg abnormalities were not influenced by litter treatment in either trial. Litter moisture levels were greater in the recycled paper chip treatment at 21 days in the first trial and were slightly but consistently elevated in the recycled paper chips throughout the second trial. Litter caking was also greater in the recycled paper chips throughout the first trial, but did not differ between treatments during the second trial.

Prior to use in the trials, pine shavings contained higher levels of bacterial and fungal contaminants. Populations of bacteria were also greater in the used pine shavings a week after completion of the second trial. However, microbial populations did not differ between treatments during the growing period of either trial.

Although litter caking and moisture levels were often greater in the paper chip treatment, production parameters were not adversely affected in either trial. Generally, litter caking and the buildup of litter moisture lead to increased occurrences of breast blisters and leg abnormalities which can decrease production performance. However, due to differences in the structure, absorbency, and texture of different litter materials, moisture and caking levels may not always increase the tendency for these problems to develop. Based on these results, it appears these chips have potential as a litter material.

R.J. Lien, D.E. Conner, and S.F. Bilgili

Lysine Requirement for Finishing Feed Differs Among Strain-Crosses

Genetic selection for growth rate and conformation has effectively increased the market weights and processing yields of broilers. However, under commercial conditions secondary influences such as nutrition, management, and diseases are often superimposed to alter the live performance and carcass yields.

In a recent study, male broilers from eight commercial strain-crosses (SC) were placed in replicated pens (40 birds per pen; 8 pens per SC) and fed common starter (23 percent crude protein, 3220 kcal metabolizable energy/kg) and grower (20 percent crude protein, 3220 kcal metabolizable energy/kg) diets during 1-21 and 21-42 days, respectively. During the finisher period from 42 to 53 days, two levels of lysine (L), 0.85 percent (LL) and 0.95 percent (HL), were fed (4 pens per SC) in the finisher diet (18 percent crude protein, 3220 kcal metabolizable energy/kg). Live performance (body weight, weight gain, feed:gain ratio, and mortality) and processing yields (abdominal fat, wing, drumstick, thigh, and deboned breast fillets and tenders) were determined.

The strain-crosses differed significantly in body weight (at 1, 21, 42, and 53 days), weight gain, and feed:gain ratio (for the periods 1-21, 21-42 and 1-53 days). Broilers on HL were significantly heavier at 53 days.

Significant differences in chilled carcass and abdominal fat weights, percent chilled carcass, abdominal fat, breast fillets, breast tenders, drumstick, thigh, and wing yields existed among the SC.

Significant response to high lysine (0.95 percent) in the finisher feed was observed for total deboned breast (fillets and tenders combined) weight and yield as a percent of chilled carcass weight (excluding the abdominal fat).

The variation observed in live performance and in processing yields of commercially available strain-crosses is attributed to differences in rate and degree of maturity at market age. The optimum lysine requirement of male broilers during the finisher period appears to be strain-cross dependent and may be higher than the 0.85 percent recommended by the National Research Council.

S.F. Bilgili, E.T. Moran, Jr., and N. Acar

Shorter Light Periods Reduce Leg Abnormalities at the Expense of Yield

Leg abnormalities are a major problem in the broiler industry. Leg problems can be reduced by restricting growth of the chicks during their first 2 to 3 weeks of life either directly by feed restriction or indirectly through manipulation of the lighting program.

The use of lighting programs to restrict feed intake has economic advantages since it does not require increased feeding equipment and allows greater bird density. However, a delicate balance must be maintained between reducing leg abnormalities and maximizing yield of edible meat. An AAES experiment was conducted to identify lighting programs which will alleviate leg problems and allow acceptable meat yields.

Day-old commercial broiler chicks were placed into one of the four light treatments. Treatment 1 was 23 hours light (L):1 hour dark (D) from

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Carcass and Yield Characteristics of Male Broilers Processed at 57 Days of Age

Variable	Result, by treatment			
	1	2	3	4
Prechilled carcass, lb. .	5.20	5.22	5.03	5.12
Chilled carcass, lb.	5.23	5.27	5.03	5.12
Abdominal leaf fat, lb. .	.18	.20	.17	.19
Lean carcass[1], lb.	5.05	5.07	4.87	4.94
Wings, lb.	.57	.57	.56	.55
Drumsticks, lb.	.73	.73	.71	.70
Thighs, lb.	.88	.90	.87	.87
Tenders, lb.	.24	.23	.22	.23
Fillet, lb.	1.01	.99	.95	.97
Cage,lb.	1.54	1.57	1.48	1.53

[1] Lean carcass = chilled carcass-leaf fat.

Shorter Light Periods, continued

1 day of age to 8 weeks of age. Treatment 2 was an intermittent schedule of 1 hour L: 3 hours D repeated from 1 day to 8 weeks of age. Treatment 3 was 6 hours L:18 hours D from 1 day to 2 weeks of age and 1 hour L:3 hours D repeated thereafter. Treatment 4 was 6 hours L:18 hours D from 1 day to 2 weeks of age and 23 hours L:1 hour D thereafter.

Body weights of birds provided short light periods (treatments 3 and 4) for their first 2 weeks of age were reduced compared to the conventional (treatment 1) and intermittent (treatment 2) light programs. However, body weights were not statistically different at 56 days of age. Feed efficiency (feed consumed per body weight) was not different among treatments.

Legs of broilers were scored visually at 42 and 57 days of age as being normal or abnormal (i.e., twisted, bowed, swollen, and/or scabby). The percentage of abnormal legs increased with age and was lower in treatment 3 compared to treatment 1. Legs were scored for the presence or absence of tibial dyschondroplasia (TD) at 13, 42, and 57 days of age. Broilers in treatment 3 showed better recovery from TD compared to other treatments at 57 days.

Carcass and yield characteristics (deboned meat plus drumsticks and thighs) are shown in the table. Carcass weights and weights of parts were lower in treatment 3 compared to treatment 1, although values were not statistically different.

The lighting program used in treatment 3 was successful in decreasing the incidence of leg problems, but meat yields were also reduced. Economic decisions can be made by the broiler industry for exchange of leg abnormalities for yield.

J.A. Renden, S.F. Bilgili, R.J. Lien, and S.A. Kincaid

EDITOR'S NOTE

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CONTRIBUTORS TO POULTRY SCIENCE RESEARCH PROGRAM 1989-90

Agri-Bio Corp.	Nutribasics Co.
Alabama Poultry & Egg Assoc.	Pitman-Moore Co.
American Cyanamid Co.	Public Health Service
Ethyl Corp.	Ralston Purina Co.
Hoechst-Roussel (Agri-Vet Division)	Ross Breeders, Inc.
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