

Nonruminant Nutrition: Vitamins and Management

695 Functional characterization of folic acid transport in the intestine of the laying hen. G. B. Tactacan*, W. Guenter, and J. D. House, *University of Manitoba, Winnipeg, Manitoba, Canada.*

The deposition of dietary supplemented folic acid (FA) into the chicken egg is likely regulated by its absorption in the intestine. Therefore, factors affecting the intestinal transport of FA in the laying hen may influence the level of egg folate concentrations. To this end, a series of experiments using intestinal everted sacs were conducted to characterize the different aspects of the intestinal FA absorption process in laying hens. Effects of naturally occurring folate derivatives (5-methyl and 10-formyltetrahydrofolate) on FA absorption were also investigated. Folic acid absorption was measured based on the rate of uptake of ^3H -labeled FA in the everted sac from various segments of the small and large intestines. Folic acid concentration, incubation length, and pH condition were set to optimum before the performance of the uptake experiments. The distribution profile of FA transport along the intestine was highest in the upper half of the small intestine. Maximum uptake rate ($\text{nmol}\cdot 100\text{ g tissue}\cdot 1\cdot\text{min}^{-1}$) was observed in the jejunum (22.3 ± 2.0) and duodenum (20.6 ± 1.9) and decreased significantly ($P < 0.001$) in the ileum (15.3 ± 1.1) and cecum (9.3 ± 0.9). Transport characteristic of FA in the jejunum demonstrated a pattern of saturation, exhibiting decreased uptake rate with increased FA concentration. Transport increased proportionately ($P < 0.002$) between 0.0001 and 0.1 μM FA but showed a trend toward saturation in excess of 0.1 μM FA. Folic acid uptake in the jejunum showed greater transport at lower pH, exhibiting highest uptake at pH 5.5–6.0 but decreased ($P < 0.009$) at higher pH (7.5). Presence of 5-methyl and 10-formyltetrahydrofolate impeded FA uptake, reducing intestinal FA absorption by 21.9 and 14.9%, respectively, when added at concentrations ranging from 0 to 100 μM . Overall, these data indicated the presence of a FA transport system in the entire intestine of the laying hen. Uptake of FA in the cecum raises the likelihood of absorption of bacterial-derived folate.

Key Words: folic acid, everted sac, laying hen

696 Effect of choline, folacin and vitamin B₁₂ on egg components and egg phospholipid composition in laying hens. P. Krishnan* and S. E. Scheideler, *University of Nebraska Lincoln, Lincoln.*

Choline, folacin and vitamin B₁₂ are essential nutrients for all animals and a required dietary supplement for poultry. This study was designed to determine the effect of added choline, folacin and vitamin B₁₂ to a corn-soy diet on egg production, egg quality and egg yolk phospholipid composition. A corn-soy basal diet was formulated with 2 levels supplemental choline (500 and 1000 ppm) 2 levels supplemental folacin (2 and 4 ppm) and 2 levels supplemental vitamin B₁₂ (0.01 and 0.02 ppm) in a $2 \times 2 \times 2$ factorial arrangement along with a control (no supplementation) group. The 9 experimental diets were arranged in a randomized complete block design with 6 replicate cages and 4 birds per cage for a total of 54 cages and fed for 6 wks. Percentage egg production, daily feed intake and body wt gain did not show any significant difference between experimental treatments as well as with the control. There was a significant ($P < 0.05$) effect of folacin on yolk wt with the wt. increasing at 2 ppm of folacin supplementation. Yolk wt also showed a significant ($P < 0.05$) 3 way interaction between choline, folacin and vitamin B₁₂. There was a significant difference in yolk wt between experimental treatments with the highest yolk wt being observed with choline, folacin and vitamin B₁₂ at 1000, 2 and 0.01 ppm respectively. Albumen wt. showed a significant difference ($P < 0.05$) with choline

and folacin supplementation with the values being higher at 1000 ppm of choline and 4 ppm of folacin. Phosphatidylcholine (PC) showed a significant increase ($P < 0.0001$) with added levels of choline, folacin or vitamin B₁₂ with subsequent reduction in phosphatidylethanolamine (PE). The average value of PC (mg/g of egg yolk) at 500 and 1000 ppm of choline was 152.61 and 164.53 mg respectively. Similarly, the average values for PC at 2 and 4 ppm of folic acid and 0.01 and 0.02 ppm of vitamin B₁₂ were 153.06, 164.07, 155.68 and 161.46 mg respectively. Results indicate that choline, folacin and vitamin B₁₂ positively affect yolk wt. and egg yolk phospholipid composition in laying hens.

Key Words: choline, folacin, vitamin B₁₂

697 Effects of canthaxanthin and 25-hydroxycholecalciferol on reproductive aspects of roosters. A. P. Rosa*¹, P. Ferreira¹, A. Scher¹, R. P. Ribeiro¹, G. Farina¹, and J. O. B. Sorbara², ¹*Universidade Federal de Santa Maria - Animal Science Department - Poultry Laboratory, Santa Maria, RS, Brazil,* ²*DSM Nutritional Products, São Paulo, SP, Brazil.*

Avian spermatozoa are characterized by high concentrations of fatty acids within their phospholipids and are susceptible to lipid peroxidation considered a problem in poultry reproduction. Antioxidant system is based on interactions of various antioxidants and the carotenoids are an essential part of that system. Among the carotenoids, canthaxanthin is characterized by its relatively high antioxidant activity. 25-OH-D3 (25-hydroxycholecalciferol) is an intermediary between the vitamin D3 and the active form of this vitamin. The aim of the present study was to evaluate the effects on the reproductive performance and seminal characteristics of roosters, fed diets with ROVIMIX MaxiChick (6 ppm Cantaxantina + 69 $\mu\text{g}/\text{kg}$ of diet 25-OH-D3). This experiment was conducted at the Poultry Laboratory of Animal Science Dept. at The Federal University of Santa Maria-Brazil. Forty White Plymouth Rock roosters from 40 to 59 weeks of age were used. The males were submitted to T1 = control diet or T2 = control diet + MaxiChick. A completely randomized design was used with 2 treatments with 20 repetitions (one male each). The experimental phase was divided into 5 periods of 28 d. The parameters evaluated were: body weight and feed intake, motility, vigor score, sperm concentration and morphological anomalies. The data were transformed to adjustment the normality and then they were subjected to ANOVA. The differences between treatments were compared by Duncan test at 10% significance level. The addition of ROVIMIX MaxiChick in the diet improved the sperm concentration from 4.40 to $5.91 \cdot 10^8/\text{ml}$ ($P = 0.0001$), motility improved from 91.40 to 92.80 ($P = 0.0071$) and sperm vigor score from 4.38 to 4.57 ($P = 0.0296$) and contributed to reduce the morphological anomalies from 21.90 to 16.70% in the semen ($P = 0.0001$).

Key Words: vitamin, D3, reproduction

698 Supplementation of canthaxanthin and 25-OH-D₃ to broiler breeders diet on broiler chick hatchery parameters and egg yolk TBARS. A. P. Rosa*¹, A. Scher¹, L. Boemo¹, T. N. N. Vieira¹, J. A. G. Ferreira Jr.¹, and J. O. B. Sorbara², ¹*Universidade Federal de Santa Maria - Animal Science Department - Poultry Laboratory, Santa Maria, RS, Brazil,* ²*DSM Nutritional Products, São Paulo, SP, Brazil.*

The objective of this study was to determine the effect of the supplementation of Rovimix MaxiChick to broiler breeders diet on hatchery parameters and the antioxidant potential. The experiment was carried

out at The Federal University of Santa Maria, Brazil. Twenty incubations were carried out with eggs from 360 females Cobb 500 with 45 weeks of age. The experimental design was in a CRD with 2 treatments, control and Control + Rovimix MaxiChick (6ppm canthaxanthin + 69mcg/kg of diet 25-OH-D3) and 6 replicates of 30 females and 3 males each. The eggs were incubated following standard incubation procedures, and at 21 d the hatchability parameters were assessed. To evaluate the antioxidant potential of Rovimix MaxiChick, eggs were stored at 0, 4, 8 and 12 d. After storage period the yolk was collected for TBARS analysis. During incubation yolks or viteline sacs of embryos were collected at 0, 7, 14 and 18 d of incubation for TBARS analysis. When MaxiChick were supplemented, Hatchability improved from 83.03% to 87.35% ($P < 0.0001$); Hatchability of fertile eggs improved from 91.30 to 93.97 ($P < 0.0001$); Fertility improved from 90.94% to 92.95% ($P = 0.0017$); Total Embryo Mortality during incubation reduced from 5.46% to 3.46% ($P = 0.0002$). TBARS (MDA mg/l protein) of egg yolks during different storage time reduced from 13.53 to 10.82 ($P = 0.0355$); from 20.87 to 15.04 ($P < 0.0001$); from 20.73 to 12.96 ($P < 0.0001$); and from 28.97 to 20.90 ($P < 0.0001$) at 0, 4, 8 and 12 d of storage, respectively. TBARS (MDA mg/l protein) of egg yolks during different incubation time reduced from 21.14 to 12.12 ($P < 0.0001$) at 0 d of incubation and from 16.69 to 14.67 ($P < 0.0001$) at 7 d of incubation. At 14 and 18 d of incubation no statistical response were detected. The supplementation of Rovimix MaxiChick in the broiler breeders diet improved all hatchability parameters evaluated in this trial. An antioxidant effect was observed in eggs from birds fed with MaxiChick.

Key Words: antioxidant, breeder, 25-hydroxycholecalciferol

699 Sparing vitamin E effects of a synthetic antioxidant blend in broilers. J. Zhao*, M. Vazquez-Anon, R. J. Harrell, J. D. Richards, F. Yan, T. Wineman, and S. Carter, *Novus International Inc.*

A total of 720 ROSS 308 female broilers were used to determine vitamin E sparing effects of a synthetic antioxidant blend (AOX, Novus International Inc., St Louis, MO). The trial was a 4×2 factorial design with 4 levels of vitamin E (5, 15, 30, and 60 IU/kg) with or without antioxidant (AOX at 0.025%). Birds were randomized into 8 treatments with 9 replicates per treatment and 10 birds per pen. Oxidized soybean oil was added in all diets to provide peroxide value of 6mEq/kg in the final diet. Without AOX, quadratic vitamin E response was observed on weight gain ($P = 0.04$) and feed intake ($P = 0.07$) with the maximum response between 15 and 30 IU/kg. AOX tended to improve feed efficiency regardless of dietary vitamin E levels ($P = 0.07$). A significant 2-way interaction of dietary vitamin E and AOX was observed on body weight and weight gain ($P = 0.05$) in that AOX improved gain at the low vitamin E but not at high vitamin E diets (interaction, $P = 0.05$). Weight gain for the 21 d growth period was 699 and 791 g at 5 IU/kg, 783 and 773 g at 15 IU/kg, 788 and 777 g at 30 IU/kg, 775 and 762 g at 60 IU/kg dietary vitamin E without and with AOX, respectively. Similar to weight gain, birds fed AOX ate more feed and had better feed efficiency at 5 IU/kg dietary vitamin E compared with birds fed non-AOX diet (by contrast, $P < 0.05$) but the benefits were not observed at high vitamin E diets. Plasma and liver vitamin E were linearly increased with increased dietary vitamin E ($P < 0.05$) regardless of AOX. In addition, plasma and liver vitamin E concentration increased with AOX addition regardless of dietary vitamin E levels ($P < 0.05$). Liver vitamin E were 8.7 and 11.1 ug/g at 5 IU/kg, 18.1 and 21.4 ug/g at 15 IU/kg, 27.8 and 36.2 ug/g at 30 IU/kg, and 51.1 and 59.4 ug/g at 60 IU/kg vitamin E without or with AOX. In summary, AOX spared vitamin E based on performance and tissue vitamin E concentration, and can be used to spare dietary vitamin E as an antioxidant in broiler diets.

Key Words: antioxidant, vitamin E, broiler

700 Effect of percentage pellet fines and house-walking schedule on broiler growth performance. W. J. Pacheco*, R. D. Malheiros, C. R. Stark, P. R. Ferket, and J. Brake, *North Carolina State University.*

Feed accounts for around 65–75% of total broiler production costs. Pelleted feed has been shown to reduce feed wastage and improve growth as it encourages broilers to eat feed faster. The objective of the study was to evaluate the effect of quantity of pellet fines and house-walking schedule on broiler growth performance. The experiment was a 2×2 factorial of pellets fines (0% or 50% fines) and house-walking (1 or 3 times daily). A total of 1,024 male 1-d-old broiler chicks were randomly assigned to 2 different blocks and 2 treatments with 8 replicate pens per treatment in each block and 32 birds per pen. The starter diet was fed in crumbled form to 21 d while the grower and finisher diets were in pelleted form. The 0% fines diet was created by screening the pellets and the 50% fines diet was created by re-combining the screened pellets with the fines. Body weight (BW) and feed consumption were determined at 21, 42, and 49 d of age and feed/gain ratio (FCR) was calculated. The fines in the 0% and 50% treatment grower diets was found to be 20% and 62%, respectively, while the finisher diets contained 3% and 54%, respectively. No pellet fines by walking treatment interaction effects were observed. The 50% fines treatment decreased 42 d BW (2,848 g vs. 2,998 g, $P < 0.0001$) and increased 1–42 d FCR (1.74 vs. 1.70, $P < 0.05$) relative to 0% fines. The 50% fines treatment continued to adversely effect 49 d BW (3,637 g vs. 3,774 g, $P < 0.0001$) but not on 1–49 d FCR (1.84 vs. 1.82). House walking 3 times daily decreased BW at 42 d (2,891 g vs. 2,954 g, $P < 0.005$) without affecting FCR. There were no walking treatment effects observed at 49 d. This experiment demonstrated the adverse effects of fines in pelleted feed on growth performance of broilers, regardless of whether they were encouraged to get up by walking the pens more frequently. Indeed, entering the pens 3 times per day may have disturbed eating and resting behavior before 42 d.

Key Words: broilers, feed fines, growth performance

701 The effects of feeder-trough space and gap setting on growth performance of finishing pigs. A. J. Myers*, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. R. Bergstrom, J. M. DeRouchey, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 288 pigs (initial BW 41.3 kg) were used in a 91-d study to evaluate the effects of feeder trough space (4.45 vs. 8.9 cm/pig) and minimum feeder gap opening of 1.3 cm (narrow), vs. 2.5 cm (wide) on finisher pig performance. Our hypothesis was that at minimal feeder trough space (4.45 cm/pig), feeders should be set at a wide gap opening to not limit feed intake and ADG. The feeders were adjusted to the minimum gap setting but the agitation plate could be moved upwards to a maximum gap opening of 1.9 or 3.2 cm, respectively. The treatments were arranged in a 2×2 factorial with 6 replications per treatment. All pens had the same feeder with 2 35.6 wide by 11.4 cm deep feeder holes. Feeder trough space was adjusted by having pens of either 8 to 16 pigs per pen. Gating was adjusted giving each pig 0.74 m² of floor space. Pigs had ad libitum access to feed and water. A corn-SBM based diet containing 20% DDGS was fed in 4 phases to all treatments. Pen weights and feed disappearance were measured every 2 wk. Overall (d 0 to 91) there were no trough space \times feeder adjustment interactions observed ($P > 0.10$). However, there was a tendency ($P = 0.08$) for increased ADG as feeder trough space increased from 4.45 to 8.9 cm/pig. Pigs fed with the wide feeder gap setting had increased ($P < 0.01$) feed disappearance and decreased ($P < 0.01$) G:F compared with pigs with the narrow feeder gap setting. These results suggest that regardless of feeder trough space, pigs with the wide feeder adjustment appeared to waste more feed as evidenced by the poorer G:F.

Table 1. Effects of feeder gap setting and feeder space on finisher pig performance, (d 0 to 91)

Item	4.45 cm trough space		8.9 cm trough space		P-value	
	Narrow	Wide	Narrow	Wide	Space	Adjustment
ADG, kg	0.99	1.01	1.02	1.03	0.08	0.33
ADFI, kg	2.99	3.16	3.04	3.24	0.18	<0.01
G:F	0.33	0.32	0.34	0.32	0.90	<0.01

Key Words: finishing pigs, feeder gap, feeder space

702 Modeling the response of growing turkeys to nutrition: from experimental to commercial data. V. Rivera-Torres*^{1,2}, P. Ferket³, and D. Sauvant⁴, ¹*Techna, Couëron, France*, ²*AgroParisTech, Paris, France*, ³*North Carolina State University, Raleigh*, ⁴*INRA-AgroParisTech, Paris, France*.

A mechanistic model was previously built to describe growth profiles of turkeys in a controlled environment. The model was further developed to be used as a predictor of turkey growth performance in commercial conditions. The model used protein and lipid turnover rates in carcass, viscera and feathers to define the expression of the growth potential in a specific environment. Feed intake depended on the limiting amino acid requirement, or on net energy utilization when no nutrient was limiting. Nutrient ingestion was assumed as glucose, amino acid and fatty acid equivalents, driven by homeostatic regulations to maintain a constant plasma concentration. Nutrient oxidation was expressed as the formation of acetyl coenzyme A. Data from calorimetry measurements and slaughter analyses were used to calibrate the model using performance of male and female turkeys fed standard diets. Protein and lipid deposition were calibrated with the turnover rates, whereas nutrient oxidation was calibrated on CO₂ production. The homeostatic response to different energy and amino acid levels was calibrated using literature data. Finally, protein and lipid deposition in carcass were adapted to the body weight (BW) and feed efficiency observed in commercial facilities, while variability between flocks was supposed to be due to feed intake differences. Based on the calibration on calorimetry measurements, females had a lower protein turnover in viscera ($P < 0.01$), and a greater

lipid turnover than males ($P < 0.01$). A 3% increase in dietary nutrient density tended to result in increased feed efficiency ($P = 0.08$), mostly because of increased protein deposition in viscera ($P = 0.05$). The variability in final BW and feed efficiency of commercial turkey flocks at 18 wk of age was due to a variation from 95 to 105% of average feed intake. The calibration on experimental data enabled the model to be used as a predictor of nutritional responses of turkey populations grown in commercial conditions.

Key Words: turkey, model, growth

703 Maximum profit feed formulation: 3. Interaction between energy content and temperature. S Cerrate* and P. W. Waldroup, *University of Arkansas, Fayetteville*.

Nutritional models for comparison of 2 environmental conditions on responses to dietary energy using data from literature were evaluated to formulate broiler diets by maximum profit feed formulation with real or simulated prices of corn and soybean meal. These diets were formulated based on corn and soybean meal (C-SBM) diets and others with wheat and cottonseed meal (+W-CM) as alternatives sources. Average body weight gain or feed intake slopes at normal temperature were significantly higher than those at heat stress. The rate of gain per calorie was 2 times higher at normal compared with heat stress and the rate of feed intake per calorie was half time higher at normal than did at heat stress. At real or simulated prices, the economic energy content in most cases was reduced by heat stress compared with those at normal temperature. For real prices the energy reductions from normal temperature to heat stress were from 3.254 to 3.015 kcal/g for diets based on C-SBM or from 3.2 to 2.961 kcal/g for diets based on +W-CM. These economic energy reductions were around 7% from real prices, up to 10% from simulated corn prices and up to 9% from simulated SBM prices. The inclusion of +W-CM reduced the economic energy content and increased the profitability compared with those based on C-SBM diets. These data indicate that broiler diets fed during heat stress should be formulated with reduced economic energy content due to decreased rate of gain or feed intake per calorie compared with those at normal temperature.

Key Words: temperature, economic energy content, profit