

369 Growth Response of a *Salmonella typhimurium* Poultry Isolate to Zinc Addition. S. Y. Park^{*1}, C. L. Woodward¹, S. G. Birkhold¹, L. F. Kubena², D. J. Nisbet², and S. C. Ricke¹, ¹ *Texas A & M University, College Station, Texas, USA*, ² *USDA-ARS, Food and Food Safety Research Unit, College Station, Texas, USA*.

It has been shown that induced molting by complete feed withdrawal increases *Salmonella* horizontal transfer in laying hens and contamination in eggs. Zinc-containing diets have been used as an alternative means to induce molt in laying as a management while avoiding feed withdrawal. It is not known if the zinc in these molt diets would inhibit *Salmonella* spp. growth and therefore potentially minimize the *Salmonella* spp. infection in individual hens. The objective of this study was to examine the effects of zinc concentration on a primary poultry isolate of *Salmonella typhimurium* growth from either nutrient rich or minimal media after inoculation. zinc sulfate (ZnSO₄) concentrations (0.67%, 2.01%, 3.35%, 4.69%, and 6.03%) were added to either 5ml of tryptic soy broth (TSB) or M9 broth after inoculation of overnight fresh culture. The growth of *S. typhimurium* poultry isolate in individual tubes at 37 °C was measured by as optical density (A₆₀₀) on a spectronic 20D spectrometer. Growth rate was determined by linear regression of change in natural logarithm of A₆₀₀ during exponential growth. Growth rate of *S. typhimurium* poultry isolate was significantly (P<0.05) decreased by the presence of zinc sulfate in M9 at concentrations greater than 2.01%. Zinc added to M9 broth at the same concentrations was much less inhibitory to *S. typhimurium* poultry isolate growth rates. The results indicate that the higher concentrations of zinc addition may be effective by inhibiting *Salmonella* spp. growth.

Key Words: *S. typhimurium*, Molting, Zinc

PSA Nutrition: Feed Regimens

371 Minimal available phosphorus requirement of molted laying hens. J.L. Snow^{*}, M.W. Douglas, A.B. Batal, M.E. Persia, P.E. Biggs, and C.M. Parsons, *University of Illinois, Urbana, IL USA*.

In an effort to diminish excessive feeding of phosphorus, our objective was to determine the minimal available phosphorus (AP) requirement for hens being molted and kept for two egg production cycles. Six replications of Dekalb Delta hens were fed diets (17% CP, 3.8% Ca) containing 0.10, 0.12, 0.14, 0.16, 0.18, 0.20 or 0.45% AP starting at 21 wk of age. Diets containing 0.10, 0.12, and 0.14% AP were terminated at 35, 39, and 50 wk, respectively, due to low egg production and increased mortality. The remaining hens were then induced molted at 64 wk of age by 10 d feed removal. Following feed removal, three replications from each previous AP level were fed either a 100% corn (C) diet or a nutritionally complete (NC) molt diet (16% CP) for 16 d. The hens were then returned to the same AP layer diet they had been fed from 21 to 64 wk. Egg production performance will be measured from 68 to 110 wk of age, with data for only the 68 to 87 wk period being reported here. During the molt period, mean body weight loss at the end of the 10 d feed removal was 22%. As expected, hens fed the NC molt diet returned to egg production faster and had significantly higher body weight gains than birds fed the C molt diet. For the 68 to 87 wk postmolt period, hens fed the 0.16% AP (163 mg/d) diet had significantly lower egg production and egg mass yield compared to hens fed 0.45% AP (P<.05). Although there were no significant (P>.05) differences in egg production among the other treatments, egg production and egg mass yield were numerically lower (P≤.1) and mortality was higher for hens fed 0.18% AP (185 mg/d) versus those fed 0.45% AP. There were no significant differences in body weight or egg weight among any treatments. Our results suggest that molted hens in their second lay cycle require approximately 0.20% AP or 210 mg AP/d. This requirement is higher than what we determined in several previous experiments for first cycle, nonmolted hens.

Key Words: Available Phosphorous, Requirement, Molting

370 Use of an alfalfa diet for molting in Leghorn hens to reduce *Salmonella enteritidis* colonization and invasion. Y.M. Kwon^{*1}, L.F. Kubena¹, C.L. Woodward², J.A. Byrd¹, R.W. Moore¹, D.J. Nisbet¹, and S.C. Ricke², ¹ *USDA-ARS, SPARC, College Station, Texas/USA*, ² *Texas A&M University, College Station, Texas/USA*.

The standard method for molting to stimulate multiple egg-laying cycles in laying hens is feed deprivation. However, the environmental changes within hens caused by feed deprivation are known to increase susceptibility of the hens to *Salmonella enteritidis* (SE) infection. In an effort to develop an alternative method to induce molting without increasing susceptibility to SE, an alfalfa diet was compared with the standard molting method for the level of molting and SE colonization. Hens over 50 wk of age were divided into three treatment groups (12 hens/group); non-molting by normal feeding (NM), molting by feed deprivation (MO), and molting by alfalfa diet (AD). The individual hens in all treatments were challenged orally with 10⁴ cfu of SE on the fourth day after feed changes, and analyzed for ovary weight and SE colonization or invasion in crop contents, cecal contents, liver, spleen, and ovary on the ninth day. In ovary weight, AD (4.8 g) was not different from MO (6.9 g) but was significantly lower (P = < 0.05) than NM (27.5 g), indicating the molting was possibly as successfully induced in AD as in MO. However, the total number of SE positive organs for all of the organs determined by enrichment technique was decreased in AD (10/60) as compared to MO (46/60), while no colonization was detected in NM (0/60). The trends of SE reduction in AD as compared to MO were consistent with all of the organs analyzed. Therefore, the results of this study suggest that an alfalfa diet has the potential to be used as an alternative method for forced molting, without increasing the incidence of SE in eggs and internal organs.

Key Words: *Salmonella enteritidis*, Laying hens-molting, Alfalfa diet

372 The effect of various levels of vitamin E supplementation in the diets of laying hens on egg yolk alpha-tocopherol content and hen performance. R. C. Johnson^{*1}, J. C. Hermes¹, R. Kampen², and A. M. Craig¹, ¹ *Oregon State University, Corvallis, OR*, ² *BASF, Abbotsford, BC, Canada*.

Two experiments were conducted to determine the effect of high levels of vitamin E in the diet of laying hens on egg yolk alpha-tocopherol content and hen performance. In experiment 1, 192, 50+ week old hens were fed one of 12 experimental diets formulated to contain 5, 10, 15, 20, 25, 100, 200, 250, 350, 400, 550, or 700 IU/kg of alpha-tocopherol for 4 weeks. Hens were selected at random, housed in individual cages and separated into four replicate treatment groups with four hens per treatment (n = 16). Daily egg production was determined along with weekly analysis of body weight, egg weight, albumen height, yolk color and yolk alpha-tocopherol content. Only egg weight and yolk alpha-tocopherol showed significant differences between dietary treatments. In experiment 2, 96 laying hens, 33 wks of age, were allocated into groups and housed as in experiment 1. The diets were formulated to contain either 15, 250, 1000, 2000, or 3000 IU/kg of vitamin E. Data collected was similar to experiment 1. After consuming the diets during the four weeks of the trial, the hens produced average egg yolk alpha-tocopherol levels of 153, 356, 607, 684, 1549, and 1394 µg/g, respectively. Results with significant differences include egg weight (P<.002), albumen height (P<.002), yolk color (P<.0001), yolk weight (P<.01), and the number of eggs produced per diet (P<.021). In both experiments, the vitamin E level in the feed significantly increased the alpha-tocopherol content in the yolk (P<.05). No signs of alpha-tocopherol toxicity were noticed at necropsy following the experiment.

Key Words: Vitamin E, Egg vitamin content, Layers

373 Nutrient requirements of Hy Line W-36, Bovans White and a new strain of Bovans White hens for optimum profits during phase I. A. Bateman^{*1}, M. Bryant, and D. A. Roland, Sr., ¹ *Auburn University*.

A study was conducted to compare performance and nutrient requirements of a new strain of Bovans White hen with the previous strain of Bovans White hen as well as Hy Line W-36 hens (weeks 21-36). Three

diets were used in each of the three strains for a 3 x 3 factorial arrangement. One diet was formulated based on protein (P-20) and contained 1.02% lysine and 18.70% protein, while two diets were formulated based on lysine which contained either 0.83% lysine and 16.19% protein (L-20) or 0.92% lysine and 17.34% protein (L-18). The criteria used were egg production, feed consumption, egg weight and egg specific gravity. Diet and strain of bird significantly effected ($p < 0.05$) egg production and egg weight. Both strains of Bovans had higher egg weight and production compared to the Hy Line W-36. Diet also had a significant effect on egg production and egg weight. Hens fed the P-20 diet had the highest egg weight and production, followed by the L-18 and the L-20. Feed consumption, egg specific gravity and feed conversion were significantly effected by strain. The old strain of Bovans had the highest feed consumption, followed by the new Bovans and the Hy Line W-36. The new strain of Bovans had the highest egg specific gravity and best feed conversion, followed by the old Bovans and the Hy Line W-36. Among the three strains, the most profits were obtained with the new strain of Bovans White. For optimum profits during phase I, the new Bovans required 998 mg lysine, 714 mg TSAA and 18.30 g protein per hen per day. These values are higher than the 690 mg lysine, 580 mg TSAA and 15 g protein per hen per day recommended by the National Research Council (NRC).

Key Words: Feed formulation, Bovans White, Profits

374 Feeding and management of Bovans White hens for optimum egg size and profits during phase I using warm temperatures. A. Bateman^{*1}, S. Yadalam, M. Bryant, and D. A. Roland, ¹Auburn University.

A study was conducted to determine the most economical nutrient (protein and lysine) level to feed during phase I (weeks 21-36) to optimize egg weight and profits when hens were exposed to warm temperatures (25.56°C average). Nine hundred and sixty 21-week old hens were randomly divided into six groups of 160 hens per group. Diets were formulated based on protein as well as lysine. The three diets formulated based on protein (0.90%, 1.02% and 1.17% lysine; 17.00%, 18.70% and 20.80% protein) each contained 2871 kcal ME/kg. The three diets formulated based on lysine (0.75%, 0.83% and 0.92% lysine; 14.98%, 16.19% and 17.34% protein) each contained 2834 kcal ME/kg. The criteria used were egg production, feed consumption and egg weight. Neither the diet or the method of formulation had a significant ($p > 0.05$) effect on any of the criteria other than egg weight. As the lysine (or protein) content of the diets increased, egg weight was significantly ($p < 0.05$) increased. Egg weight was also significantly ($p < 0.005$) higher in the diets formulated based on protein versus the diets formulated based on lysine. Egg production peaked at greater than ninety-five percent in birds in all treatments at 33 weeks of age, and remained over eighty-eight percent for the remainder of the study. Using an economic analysis, it was shown that for optimum profits Bovans White hens required 1,076 mg lysine, 750 mg TSAA and 19.1 g protein per hen per day during phase I. These values are higher than the 690 mg lysine, 580 mg TSAA and 15 g protein per hen per day recommended by the National Research Council (NRC).

Key Words: Feed formulation, Bovans White, Profits

375 Evaluation of non-feed removal versus feed removal methods for molting programs. P.E. Biggs^{*}, M.W. Douglas, K.W. Koelbeck, and C.M. Parsons, University of Illinois, Urbana, IL USA.

The objective of this study was to determine the effects of feed removal versus feeding high corn or wheat middlings diets as induced molting techniques. An experiment was conducted using 336 White Leghorn hens (60 wks of age) randomly assigned to one of four treatments that consisted of feed removal for 4 or 10 d or no feed removal with *ad libitum* access to 95% corn or 95% wheat middlings molt diets containing supplemental vitamins and minerals. At the end of the 4 or 10 d feed removal period, hens on these treatments were provided with the corn molt diet for 24 or 18 d, respectively. Hens on the corn or wheat middlings treatments were fed the diets for 28 d. At 28 d, hens on all treatments were fed a corn-soybean meal layer diet (16% CP). Both feed removal and the wheat middlings treatments resulted in total cessation of egg production within 8 d. Egg production of hens fed the corn molt diet had decreased to 3% by 28 d. Body weight loss for hens fed the corn or wheat middlings diets was approximately 9% at 28 d. Hens fed the

wheat middlings diet returned to production slightly faster than hens on the other treatments. Post-molt egg production (6 to 28 wks after initiation of the molt treatments) was generally higher for the wheat middlings and 10-d feed removal treatments than for the corn and 4-d feed removal treatments. Average feed intake for Weeks 2 to 4 during the molt period and Weeks 5 to 8 on the layer diet was highest ($P < 0.05$) for the wheat middlings treatment, with all other treatments being similar during these periods. No differences in feed intakes were observed among treatments after Week 8. There were no consistent differences in mortality, post-molt egg weight, egg specific gravity, and Haugh units among treatments. This research indicates that feeding high corn or wheat middlings diets, particularly wheat middlings, are effective non-feed removal methods for molting hens.

Key Words: Induced Molting, Feed Withdrawal, Laying Hens

376 The effect of midnight feeding on feed consumption and eggshell quality in commercial laying hens. A. Petruk^{*1}, D.R. Korver¹, R.A. Renema¹, and M.J. Zuidhof², ¹University of Alberta, ²Alberta Agriculture, Food, and Rural Development, Edmonton, AB, Canada.

The effect of allowing laying hens access to feed for 1 hour at midnight to prevent perturbations in eggshell quality and calcium status was investigated. Two trials were performed using 60 wk old SCWL Shaver 2000 hens (48 hens/experiment). Experiment 1: The hens were exposed to midnight feeding for 27 weeks prior to the study. Half of the hens ($n=24$) were allowed continued midnight feeding (MF treatment) while the other half ($n=24$) had their feeder removed at 2000h and replaced at 0500h to prevent overnight feed intake (CONT treatment). Experiment 2: Experimental conditions and treatments were as described in Experiment 1, except the hens had no prior exposure to midnight feeding. Daytime (0500h to 2000h), night (2000h to 0500h) and total daily feed consumption were recorded daily for each hen; BW was recorded weekly. All eggs were collected and shell quality assessed. Egg specific gravity, yolk weight, and dry shell weight were measured 3 times/wk. The MF hens in Experiment 1 gained more weight than CONT birds (MF, 49.30g; CONT, -15.52g) and relative gain was also higher (MF, 2.51%; CONT, -0.77%) with no differences in Experiment 2. Egg production did not differ in either study, although differences in total (MF, 26.87; CONT, 23.70) ($P = 0.0573$) and settable (MF, 26.61; CONT, 23.39) ($P = 0.0600$) egg production rates approached significance in Experiment 1. Egg weight, shell weight, specific gravity, and yolk weight showed no differences in either experiment. In Experiment 1 (prior exposure to midnight feeding) there were no treatment differences in daytime or total weekly feed consumption. In Experiment 2 (no prior exposure to midnight feeding) daytime consumption of the CONT hens was higher for every week of the study, demonstrating that MF hens had shifted their feeding patterns. Specific advantages of a midnight feeding program on shell quality or egg production were not demonstrated under the experimental conditions of this study.

Key Words: Midnight feeding, Feed consumption, Eggshell quality

377 Effects of commercial strain, dietary sodium bicarbonate level, or animal fat versus vegetable oil addition to feed on performance of caged White Leghorn laying hens from 36 to 48 weeks old in summer. L. R. Minear^{*1}, D. M. Hooe², and K. R. Cummings, ¹Southern States Cooperative, Richmond, VA, ²Hooe Consulting Service, Inc., Eagle Mountain, UT, ³Church & Dwight Company, Inc., Princeton, NJ.

About 6,336 caged White Leghorn hens, 36 wk of age, were used in a 12-wk trial to evaluate effects of strain (Hy-Line W-98, HYL; Bovans, BOV) and dietary treatments in a 2 x 5 factorial arrangement. Phase II diets were: 2.5% animal fat (AF) control basal (CON); CON basal with 0.3, 0.4, or 0.5% level of sodium bicarbonate (SB) in place of an equal amount of brewers grains, with corn and soy adjustment; or 2.5% vegetable oil (VO) feed. The practical corn-soy, brewers grains based diets contained BASF phytase, limestone, and oyster shell. All feeds were formulated to contain calculated potassium (K) and chloride (Cl) levels of 0.71% and 0.21%, respectively, whereas calculated sodium (Na) varied from 0.174% in CON to 0.261, 0.349, and 0.436% in the respective sodium bicarbonate diets. Dietary electrolyte balances, Na+K-Cl in mEq/100 g, were about 19.7 (animal fat or vegetable oil basal diets), 23.2, 24.4, and 25.6, respectively. There were 160 experimental (replicate) units with around 40 hens each (4 or less/conventional cage).

Stocking density was about 0.039 m²/hen. The study was conducted in Virginia from July through September. Significance was by LSD (T method) at P<0.05. The HYL layers had higher livability, feed/dozen eggs, egg weight, albumen weight, and wet shell weight, but lower hen-day egg production and yolk weight than BOV laying hens, with no differences in daily feed intake or egg mass output. The VO supplement tended to increase egg weight (P=0.18) and albumen weight (P=0.11) compared to AF addition. Increasing levels of SB increased feed intake, feed/dozen eggs, feed/kg egg, and yolk weight compared to CON. This increase in feed intake in summer with SB may be due to partial replacement of Cl by HCO₃ in blood lowering dietary "effective Cl" level (as increasing Cl depresses feed consumption based on previous research) or to additional Na increasing water intake and bird cooling, or both. Yolk weight increased from 16.8 to 17.1 g with 0 vs 0.3% SB when feed intake correspondingly increased from 97.2 to 98.7 g/hen/day, associated with +0.018 kg feed/dozen eggs and +0.010 kg feed/kg eggs. Dietary SB at 0.3 to 0.5% increased feed intake and yolk weight, with slight increases in feed per dozen or per kg of eggs in summer.

Key Words: Animal fat, Sodium bicarbonate, Vegetable oil

378 Evaluation of phytase release factors in broiler diets containing different levels of amino acids. W. Pan*, F. Yan, C. A. Fritts, and P. W. Waldroup, *University of Arkansas.*

In addition to its effects on release of phytate-bound P in poultry diets, phytase may release additional nutrients such as amino acids and carbohydrates making more energy available to the chick. However, the research supporting this additional nutrient release is inconsistent and controversial. A study was conducted in which a series of diets with minimum amino acid (AA) levels ranging from 85 to 115% of NRC (1994) recommendations were formulated 1) without consideration of the nutrients released by phytase; and 2) considering the nutrients released by 600 units/kg of phytase (Natuphos® BASF). Calcium and nonphytate P were at levels suggested by the NRC, also taking into consideration the release of these nutrients by phytase. Therefore performance should be equal on diets with and without phytase supplementation if the nutrients are released. Each diet was fed to six replicate pens of 25 male chicks maintained in litter pens. Body weight and feed conversion (FCR) were determined at 21 and 42 d. At 42 d tibia were taken from 5 birds per pen. The left tibia was ashed and the right tibia scored for incidence and severity of tibial dyschondroplasia (TD). Overall, performance of chicks fed diets with or without phytase did not differ significantly for any measurement. Performance was influenced by dietary AA level, and there was a significant interaction of AA level x phytase supplementation for BW and FCR with addition of phytase improving performance at some AA levels, depressing performance at other levels, and being equal at some levels. The AA levels significantly influenced the incidence and severity of TD. Tibia ash was not significantly influenced by AA levels or by phytase supplementation. These data suggest that the nutrient release factors might be used when supplementing diets with phytase but results may be highly variable.

Key Words: Phytase, Nutrient release, Amino acids

379 Effects of glycine and threonine supplementation on performance of broiler chicks fed diets low in crude protein. Qi Jiang*, C. A. Fritts, and P. W. Waldroup, *University of Arkansas, Fayetteville, AR.*

Reduction of crude protein by use of crystalline amino acids has been successful to a point but performance eventually declines. Previous work from our laboratory indicates that reducing CP in broiler starter diets below 20% adversely affects performance even though essential amino acids were more than 110% of NRC (1994) recommendations. In recent studies we determined that additional Gly but not Pro, Arg, or Glu improved performance on diets low in CP. The present study investigated the use of both Gly and Thr at levels in excess of NRC recommendations. Diets based on corn and soybean meal were formulated to contain from 16 to 24% in 2% increments. All essential amino acids were at 100% of NRC recommendations with lysine at 110%. Crystalline amino acids were added as needed. The treatments consisted of the five levels of CP, three additional levels of Gly (0, 0.2, 0.4%) and three levels of Thr (0, 0.2, and 0.4%) in all possible combinations. Each diet was fed to six pens of 6 male broiler chicks in battery brooders. Diets with 20% or less CP resulted in significant reduction in BW and feed conversion even though meeting all known amino acid requirements. Addition of Gly but

not Thr significantly improved BW, especially at the lower CP levels. However performance was still less than obtained on diets with 22 and 24% CP. These data suggest that other amino acids may be deficient in diets low in CP.

Key Words: Glycine, Threonine, Broilers

380 Efficacy of Ronozyme P™ liquid phytase and Natuphos® liquid phytase in broiler starter diets. J. Broz¹, A. Klunter¹, N.E. Ward*², and J.W. Wilson², ¹*Roche Vitamins, Basel, Switzerland,* ²*Roche Vitamins Inc., Parsippany NJ.*

Two similarly-designed experiments compared Ronozyme P™ Liquid (RL) and Natuphos® Liquid (NL) for broilers taken to 22 days of age. Day-old Ross chicks were fed a low phosphorus (P), mash, corn/SBM diet through day 8, after which the birds were allocated by weight to one of three diets: negative control (NEG; 0.51% total P, 0.76% Ca); RL, 500 FYT/kg in NEG; NL, 500 FTU/kg in NEG. Eight (8) replications/treatment (4 groups of males, 4 groups of females) were fed through day 22. Excreta was collected from days 14-17 to determine apparent P and calcium (Ca) retention.

There were no treatment x sex interactions (P>.05), thus data were pooled across sexes. Results for the second experiment mirrored those of experiment 1. Body weight and F/G (adjusted for mortality) were improved (P<.05) with both phytase sources, whereas mortality was unaffected (P>.05) by trt. P and Ca retention were increased (P<.05) by phytase treatments. P and Ca in excreta were decreased (P<.05) equally (P>.05) by the addition of either phytase source to the diet. For both experiments, 500 units phytase/kg diet from either source were found to be equivalent for all variables tested.

Variable	NEG	RL	NL
Phytase, analyzed units/kg	—	618	665
Body wt. gain g/bird	477 ^b	501 ^a	512 ^a
F/G	1.564 ^a	1.526 ^b	1.509 ^b
P-retention g/bird/day	0.157 ^b	0.183 ^a	0.194 ^a
Ca-retention g/bird/day	0.231 ^b	0.279 ^a	0.294 ^a

NEG = negative control; RL = Ronozyme™ P Liquid; NL = Natuphos® Liquid; ab P<.05

Key Words: Ronozyme P™ Liquid, Phytase, Broilers

381 An evaluation of Ronozyme P™ CT in broiler diets in a 36-day floorpen study. J. Broz¹, A. Klunter¹, N.E. Ward*², and J.W. Wilson², ¹*Roche Vitamins, Basel, Switzerland,* ²*Roche Vitamins Inc., Parsippany NJ.*

This 36-day floorpen study was designed to compare two commercial sources of dry phytase in a corn/SBM diet. Ronozyme P™ CT (RCT) was added to provide 500, 750 and 1,000 FYT/kg feed, while Natuphos® G (NG) was added at 500 FTU/kg diet. All treatments were cold-pelleted to minimize destruction of NG. Each treatment was replicated 8 times with 20 birds/replication (4 groups of each sex). The negative control (NEG) diet, to which each phytase treatment was added, contained 0.51% total P and 0.83% Ca. A positive control contained 0.61% total P and 0.91% Ca.

There were no (P>.05) treatment x sex interactions, thus all groups were pooled for data evaluation. Analyzed phytase values post-pelleting were in agreement with target values, excepting RCT 1,000 FYT/kg, which appeared erroneous based on actual addition rate. Supplementation of phytase increased (P<.05) body weights and feed intake over that of NEG, but no difference (P<.05) was noted across phytase source. F/G of RCT (750 FYT/kg) was improved (P<.05) over that of NG (500 FTU/kg), while no difference existed within RCT levels. Mortality was unaffected (P>.05) by treatment. Day 36 tibia ash did not differ (P>.05) across phytase level or source, but the addition of phytase increased (P<.05) bone ash over NEG. Over a 36-day period, the two sources of phytase at 500 units/kg were not different (P<.05) for any variable tested, although there was a tendency for RCT to more favorably influence F/G.

Variable	NEG	RCT-500	RCT-750	RCT-1000	NG-500	POS
Analyzed phytase, units/kg	140	479	734	787	516	111
Body wt., g	1800c	1920b	1965ab	1962ab	1945b	2026a
Feed intake, g	2708c	2894b	2936b	2941b	2964b	2137a
F/G	1.506bc	1.508bc	1.497c	1.502bc	1.526ab	1.545a
Mortality, %	3.1	7.5	4.4	5.0	5.6	3.8
Tibia ash, % dry matter	49.7c	51.6b	51.6b	52.3ab	51.8b	53.1a

NEG, negative control; RCT, Ronozyme PTM CT; NG, Natuphos[®] G; POS, positive control; abcP<.05

Key Words: Ronozyme PTM CT, Natuphos[®] G, Floorpen broiler study

382 Reassessment of Trypsin Inhibitor Activity in Guar Meal. S.R. Conner*, A.L. Cartwright, and C.A. Bailey, Texas Agricultural Experiment Station.

Guar (*Cyamopsis tetragonoloba*) is a drought resistant annual summer legume grown primarily for its galatomannan polysaccharide gum. In the separation of the gum containing endosperm, two distinct fractions are obtained. The first fraction from the splitting of the guar bean has higher germ content and the second fraction removes the hull from the remaining gum containing endosperm. A third fraction results from a combination of the two fractions. Although guar meal can be used as a source of vegetable proteins in animal feeds, a major impediment to protein digestibility is commonly attributed to a trypsin inhibitor. De-fatted raw soybeans, dehulled soybean meal and three guar fractions evolved from various stages of guar gum production were assayed for trypsin inhibitor activity using the American Oil Chemists' Society official method Ba 12-75. Results indicated that the trypsin inhibitor

activity of the raw guar beans, guar splits (gum), and the three guar meal fractions were substantially less than the trypsin inhibitor activity of heat treated dehulled soybean meal. Trypsin inhibitor activity is likely not the significant impediment to protein utilization in guar meal.

Key Words: Guar, Guar meal, Trypsin inhibitor

383 Immobilization of Keratinase-Streptavidin Fusion Protein for Keratinolysis. J.C.H. Shih* and J.-J. Wang, North Carolina State University, Raleigh, NC USA.

Keratinase, produced from *Bacillus licheniformis* PWD-1, is capable of hydrolyzing chicken feather keratin. Immobilized keratinase has many potential applications, including the conversion of ground feathers to soluble protein, peptides and amino acids. A biotechnology for keratinase immobilization has been developed. Fusion genes of keratinase (KER) and streptavidin (STP) were genetically constructed. Transformed *B. subtilis* and *E. coli* expressed and produced the bifunctional fusion protein, KER-STP. Isolation and immobilization were achieved by mixing a biotinylated solid matrix with the *B. subtilis* medium or the *E. coli* lysate. Since the fusion protein was produced intracellularly in the inclusion body of *E. coli*, the extraction and renaturation from the cell lysate were laborious and consequently caused a low yield. *B. subtilis* produced and secreted the fusion protein that can be readily immobilized from the medium. The properties of immobilized keratinase-streptavidin fusion protein were characterized. Heat stability, durability, and pH tolerance were found greatly improved. Kinetic parameters of immobilized keratinase, including V_{max}, K_m, and k_{cat} toward the peptide substrate were also determined and compared with the free enzyme. Hydrolysis of three different substrates, insoluble feather keratin, soluble α-casein and bovine serum albumin (BSA) were carried out and analyzed by HPLC. It is interesting to note that keratinolysis by both immobilized and free keratinase produces a characteristic soluble protein with a molecular weight of 18 kDa. (Patent application pending)

Key Words: feather keratin, keratinase, enzyme immobilization

PSA Physiology

384 Performance and Thermo Tolerance of Broilers as Affected by Genotype and Ambient Temperature. H. A. Al-Batshan* and E. O. Hussein, King Saud University, Riyadh, Saudi Arabia.

This experiment was conducted to evaluate the effects of genotype (GT) and ambient temperature (AT) on subsequent performance and body core temperature (CT) of broiler chicks. A factorial arrangement of two GT (Hubbard and ISA) and two rearing AT (either under 33 C and then AT was reduced to 23 C by wk 4, or under constant AT of 33 C throughout the trial) was used in this study. Diurnal CT was monitored continually (2 min intervals) for 4 days using a biotelemetric system at six weeks of age. Results showed that weight gain and feed intake were significantly increased but feed:gain ratio was significantly decreased for Hubbard chicks compared to those of ISA chicks. High AT significantly reduced weight gain and feed intake. There was significant GT by AT interaction for weight gain, revealing that Hubbard chicks were more affected by high AT. Ambient temperature and GT significantly affected CT. Moreover, core body temperature of ISA chicks was significantly higher at the moderate ambient temperature but was significantly lower at the high ambient temperature than those of Hubbard chicks, which resulted in significant GT by AT interaction. The results of this study indicated that chicks with higher growth potential are more susceptible to heat stress.

Key Words: Broilers genotype, Ambient temperature, Diurnal body temperature

385 Changes in Growth and Function of Chick Small Intestine Epithelium Due to Heat Exposure Conditioning. Zehava Uni*¹, Orit Gal-Garber¹, Assaf Geyra¹, David Sklan¹, and Shlomo Yahav², ¹Faculty of Agriculture, Department of Animal Science, The Hebrew University of Jerusalem, Israel, ²Institute of Animal Sciences, ARO, The Volcani Center, Bet-Dagan, Israel.

The effect of exposure to heat at 3 d of age on small intestine functionality and development was assayed by measuring villus size, proliferating enterocytes, and brush-border membrane enzyme expression and activity. Results showed that thermal conditioning caused an immediate effect characterized by lowered triiodothyron (T3) level, reduced feed intake, and depressed enterocyte proliferation and BBM enzyme activity. A second series of effects, observed 48 h posttreatment, was characterized by elevated T3, increased feed intake, increased enterocyte proliferation, and higher expression and activity of BBM enzymes. The association between ambient temperature, feed intake, growth rate, and plasma T3 levels was reflected in the structure and function of the intestinal tract. The results suggest that thermal conditioning at an early age influences T3 concentrations, which in turn alters the intestinal capacity to proliferate, grow and digest. However, these experiments were not able to separate between the effects due to feed intake from those due to thermal conditioning. These changes modulate the intestinal tract for compensatory growth commencing 48 h postthermal treatment.

Key Words: Heat, Small intestine, Chicks

386 Origin of thermal-load induced adaptations in intestinal hexose absorption: heat stress or reduced food intake? M.A. Mitchell*¹, R.R. Hunter¹, M. Moreto², C. Garriga², M. Mitjans², C. Amat², and J.M. Planas², ¹Roslin Institute, Roslin, Midlothian, UK, ²University of Barcelona, Barcelona, Spain.

Previous studies demonstrated increased expression of SGLT-1 transporters in the brush border membranes of enterocytes from chronically