hatch. The birds were reared to 10 wks. Mortality and feed consumption were monitored. Birds were weighed at 6 and 10 weeks of age. Period and cumulative feed conversion (FC) ratios were calculated. Regression analysis of SAS, Inc. was used for data analysis. LS Means procedure was used to separate treatment means (P<0.05). At placement, T1 hens (59.9 g) were heavier than T3 (58.8 g) or T4 (59.0 g) but not T2 (59.4 g) hens. At 6 wks, T3 hens were heavier than T1 (1.78 kg), T2 (1.80 kg) or T4 (1.81 kg) hens. At 10 wks, there were no differences in BW (5.42 kg) for treatments. There were no differences for 6 wk (1.44) 10 wk (1.78) or 6 to 10 wk (1.95) PC. LT did not affect mortality. Litter treated by the process used for this study produces a bedding material suitable for rearing market turkeys.

Key Words: Poultry litter, Turkey performance, Litter treatment

141 Influence of stocking density on use of space in ostrich chicks. T. Cornett*, I. Estvez, and R. Angel, Animal and Avian Sciences, University of Maryland, College Park, Maryland.

Survivability of ostrich chicks raised in captivity is a concern for ostrich growers and studying their behavior may provide insights on chick management. Physical and social space requirements may impact animal behavior. In many poultry species, stocking density has been shown to influence feeding, drinking, resting, locomotion and foraging and has been linked to increased competition for resources and aggression among conspecifics. Applying this to ostriches, we hypothesized that monopolization of space containing resources will occur and as density increases a larger percentage of birds will be observed in the regions lacking resources. The present study investigated the effects of density on the use of space by ostrich chicks. Birds (144) were reared in outdoor pens (268 m²) from 19 to 98 d of age. All pens were planted with intermixed clover (25%) and rye grass (75%) and were equipped with a dustbath area (4 m²) and a shelter (3.3 m²) in which the birds were kept nightly until 75 d of age. Chicks were randomly assigned to nine pens using a complete block design. There were three density treatments (three replicates) that consisted of low, moderate and high with 33.5, 16.8 and 11.2 m²/bird, respectively. Observations on the use of space in each pen were taken by instantaneous scan samples in two-wk periods. A grid system was used to divide each pen into four regions with (shelter, dustbath) and without (periphery, center) resources. For each pen, the total number of birds using each region was recorded 18 times per period for 10 wk. Use of space was not influenced by density (P>0.05). There was a significant interaction between age and region occupied (P<0.001). The average percentage of birds using each region was highest (P<0.05) in the periphery (56%) and lowest (P<0.05) in the center (8%) and dustbath (11%) regions for all three densities. Although use of space was not uniform, these results suggest that monopolization of space did not occur in ostriches. These findings have implications on management.

Key Words: Behavior, Use of Space, Stocking Densities, Ostriches

142 Effect of litter condition on putrefaction and lactic fermentation of poultry carcasses. N.M. Tamim*, R.A. Dalloul, T.A. Shellek, and J.A. Doerr, Dept. of Animal and Avian Sciences, University of Maryland, College Park, MD/USA.

Apparent differences in decomposition seen in prior putrefaction and fermentation experiments prompted this study which was designed to characterize the effects of "wet" vs. "dry" litter on spoilage of carcasses and quality of subsequent lactic fermentations. Day-old male broiler chicks were reared in floor pens with either relatively "wet" (40% moisture) or "dry" (20% moisture) litter. At 28 days of age, birds were killed and putrefied on their respective litter at 30°C and 70-80% RH for 0, 18, 36, or 54 hours. At each time period, 18 carcasses were ground, sampled for microbial analysis, mixed with whey and corn, and fermented at 37°C for 120 days. After 48 hours fermentation, all treatments, except those putrefied on wet litter for 36 hours or more, were below pH 4.5, which is considered a threshold for a good quality ferment. The pH for all treatments was below 5.0; however, only mixtures of carcasses putrefied for 18 hours or less kept a pH below 4.5 throughout the 120 day period. Total aerobes, anaerobes and lactobacilli increased with increasing putrefaction, and increased further in the first 48 hours of fermentation. After 48 hours fermentation, all populations were declining. Bacterial count was dependent on putrefaction time, and this response was litter-dependent. These data show that litter management and rapid collection of mortality are both crucial to the quality of lactic fermentation-preserved carcasses.

Key Words: Litter, Broilers, Putrefaction, Lactic fermentation, Bacteria

143 Use of Stable Nitrogen Isotopic Tracers to Differentiate Nitrogen Sources in Groundwater Proximate to Poultry Operations. C.M. Williams†, W.J. Showers, and B. Coffer, North Carolina State University, Raleigh, North Carolina / USA.

The purpose of this investigation was to utilize stable nitrogen isotope geochemistry technology to differentiate nitrogen nutrients in drinking water wells located near poultry operations. Previous studies have shown that this technology can be used to differentiate nitrogen sources from commercial fertilizer, human sewage, swine, dairy, and poultry manure. Twenty wells, previously identified in a state government sponsored well testing program as problematic due to measured elevated concentrations of nitrate, were sampled quarterly over 1 year and quantified for nitrate concentration and stable nitrogen isotopic enrichment. Nitrate concentrations ranged from 2 - 50 ppm; stable nitrate (N-15) ranged from -1 to +25 per mil. Poultry and livestock manures have been shown to generally enrich the heavier nitrogen (N15) isotope and show isotopic "signatures" in the +17 to + 27 per mil range; liquid poultry manure is characteristically in the +25 to +27 range. In this study only 1 of the 20 wells consistently showed N15 enrichment characteristic of poultry manure. Although more work is required to definitively establish nitrogen isotopic enrichment from litter based poultry manure, this study indicates that the high concentrations of nitrate measured in these wells is from sources other than poultry excreta.

Key Words: poultry waste, nitrogen, stable isotopes, groundwater, nitrate

Saturday, PM, ENVIRONMENT AND MANAGEMENT B

144 Temperature stratification in broiler houses during cold and hot weather. M. Czarick* and M. P. Lacy, The University of Georgia, Athens, GA 30602-4356.

Air temperatures were measured on commercial broiler farms to determine how floor to ceiling temperature profiles changed throughout the life of a flock during cold and warm weather. Air temperatures at a height of 10 cm, 90 cm and 3.4 m (at ceiling) above the floor in dropped ceiling 10 wk-old ventilated broiler houses were recorded throughout the life of multiple flocks. Temperature stratification during brooding was a function of the amount of space by ostrich chicks. Birds (144) were reared in outdoor pens (268 m²) from 19 to 98 d of age. All pens were planted with intermixed clover (25%) and rye grass (75%) and were equipped with a dustbath area (4 m²) and a shelter (3.3 m²) in which the birds were kept nightly until 75 d of age. Chicks were randomly assigned to nine pens using a complete block design. There were three density treatments (three replicates) that consisted of low, moderate and high with 33.5, 16.8 and 11.2 m²/bird, respectively. Observations on the use of space in each pen were taken by instantaneous scan samples in two-wk periods. A grid system was used to divide each pen into four regions with (shelter, dustbath) and without (periphery, center) resources. For each pen, the total number of birds using each region was recorded 18 times per period for 10 wk. Use of space was not influenced by density (P>0.05). There was a significant interaction between age and region occupied (P<0.001). The average percentage of birds using each region was highest (P<0.05) in the periphery (56%) and lowest (P<0.05) in the center (8%) and dustbath (11%) regions for all three densities. Although use of space was not uniform, these results suggest that monopolization of space did not occur in ostriches. These findings have implications on management.

Key Words: Behavior, Use of Space, Stocking Densities, Ostriches

Temperature stratification during brooding was a function of the amount of time brooders/furnaces were operating almost constantly, air temperature stratification was as much as 1.7 degrees C per 30 cm. Since furnace/brooder thermostats are often placed between 60 and 90 cm off the floor, broiler producers are very likely to be brooding at air temperatures lower than typically recommended. This fact was verified in spot measurements made on over a dozen farms during brooding where air temperature at floor level was approximately 2.8 degrees C lower than

at thermostats levels resulting in growers brooding at air temperatures in the 27-29 degree C range. The use of small mixing fans during brooding was examined as a method of breaking up temperature stratification. Mixing fans were found to reduce temperature stratification to less than 0.3 degrees C per 30 cm. As a result, floor temperatures in houses with mixing fans were approximately 2.8 degrees C warmer than those in houses without mixing fans. Fuel usage in houses with mixing fans was found to be as much as 30% lower as compared to houses without mixing fans. During warm weather, air temperatures at floor level were often warmer than those 90 cm above the floor. How much warmer the air was at floor level depended on bird age as well as air velocity. With large birds and low air velocity, the air temperature at floor level was as much as 2.2 degrees C warmer than air temperature 90 cm above the floor.

Key Words: Air Temperature, Fuel Usage, Stratification, Broilers, Housing
145 Exploring the relationship between environment and broiler performance on a commercial broiler farm. M. Czarick* and M. P. Lacy, The University of Georgia, Athens, GA 30602-4356.

There is little question that today's broiler is much more sensitive to environmental conditions as compared to the broiler of just 10-20 years ago. Performance of these fast-growing, high-yield strains is known to be influenced by temperature, humidity, air quality, light intensity, photoperiod, density, litter conditions and a host of other environmental parameters. Precise control of these parameters is of great concern to broiler producers; however, of more value would be reliable information on exactly how these factors influence performance and profitability under actual field conditions. The purpose of this project was to take advantage of computer technology to attempt to monitor and control the environment inside the broiler house and to more effectively collect and analyze production data.

Two black-curtained, tunnel-ventilated broiler houses were equipped with modern microprocessor based environmental controllers to explore the relationship between environment and broiler performance on a commercial broiler farm. The controllers were capable of monitoring the status of all environmental control devices (fans, brooders, side wall inlets, tunnel curtain, etc.), air temperature at six locations within the house, relative humidity (one location) and bird water consumption. The houses were also equipped with feed bin scales, bird scales, as well as ammonia meters. The environmental controllers, bird scales, bin scales, and ammonia meters were linked to a personal computer for data storage and display. The personal computer was equipped with a modem so that data could be monitored from remote locations, i.e., broiler company live production office, campus, producer’s home, etc. Results of this project indicate that variation and inefficiencies in broiler house environments can be significantly reduced utilizing advanced technology.

Key Words: Broilers, Environmental Conditions, Controllers, Performance

146 Wind velocity - its effect on the performance and thermoregulation of broiler chickens exposed to high ambient temperature. S. Yahav*1 and A. Straschnow1, 1 Institute of Animal Science, ARO The Volcani Center.

Wind velocity plays a crucial role in heat loss by convection. Despite the fact that its role in the overall heat loss declines with the increase in ambient temperature (Ta), it contributes to the reduction of evaporative heat loss and by that to the improvement of water content balance of the body. The aim of the following study was to evaluate the effect of different wind velocities on the performance and thermoregulation of male broiler chickens. Two hundred and forty broilers ( Cobb) were housed in 4 environmental controlled (Ta ± 1.0 C; rh ± 2.5%; air velocity ± 0.25 m/s) chambers, at the age of 4 weeks. During one week of acclimation, the experiment-targeted conditions were achieved. The conditions were 35 C; 60% rh and 4 treatments of different wind velocities (0.5, 1.5, 2.0 and 3.0 m/s). On a weekly basis body weight, feed intake (n=240), body and skin temperatures (n=16) were measured and brachial vein blood samples (n=16) were collected. Broilers exposed to 1.5 and 2.0 m/s wind speed exhibited a significantly higher body weight (2203±30.6, 2429±43.2, 2462±37.1, 2300±32.9 g for 0.5, 1.5, 2.0 and 3.0 m/s, respectively). It coincided with significantly higher feed efficiency. Hyperthermia was observed in all treatments, however, a significantly higher values of skin temperature were measured in chickens exposed to 1.5 and 2.0 m/s. (42.30±0.16 and 42.29±0.12 C, respectively) compared with skin temperature of 41.95±0.21 and 41.79±0.16 C in chickens exposed to 0.5 and 3.0 m/s, respectively. The skin temperature was significantly higher than the body temperature. Plasma thyroxine, triiodothyronine and arginine vasotocin concentrations were found in plasma thyroxine, triiodothyronine and arginine vasotocin concentration. These results suggest that wind velocity play an important role in the performance of broiler chickens. Its significant role in thermoregulation has to be elucidated.

Key Words: Wind velocity, Broiler, Skin temperature, Performance

147 The Effect of Different Air Velocities on Broilers in a Cyclic Temperature. B. D. Lott1*, J. D. Simons1, J. D. May1, and S. L. Branton1, 1 USDA-ARS South Central Poultry Research Lab.

Previous work at our laboratory demonstrated improvements in body weight gain and feed conversion of broilers in warm temperatures for an air velocity of 120 mpm as compared to still air. The objective of this research was to determine the effect of air velocity on performance at a lower, cyclic temperature representative of spring and fall rearing temperatures. Broilers were raised at seven levels of air movement using normal brooding practices and fed a basal diet through 3 weeks of age. The treatments were air velocities of 120 and 60 mpm and a still air control. The air velocity treatments were applied in two wind tunnels that were located inside an environmentally controlled house. Each tunnel had four pens. Six conventional pens in the same house were used for still air controls (<15 mpm). Each conventional and tunnel pen was stocked with 53 3-wk old birds. The temperature was a diurnal cycle of 18-28-18 C with a constant 15 C dewpoint. The experimental period was 3 to 7 wks of age and body weight gains and feed data were collected weekly. Our previous data showed that broilers benefited from 120 mpm air velocity in a 25-30-25 C cyclic temperature at body weights >2400 g. Our current results demonstrate that an improvement in performance occurred >2700 g in an 18-28-18 C cyclic temperature. Performance was not improved at 60 mpm compared to still air. It is concluded that at cooler ambient temperatures, broilers must be heavier to obtain a benefit in performance from an increased air velocity.

Key Words: air velocity; weight gain; temperature


The effects of ventilation rate per bird, air speed at bird level and bird disturbance on broiler performance, carcass quality and the microclimate of the bird (ambient and litter temperature) was measured. The high and low ventilation rate treatments corresponded to 3.4 and 1.7 L/s/bird, respectively. The air speed treatments were provided by fans directing air at the birds (0.82 m/s vs 0.32 m/s). Bird disturbance treatments occurred by automatic feeding or hand feeding. Two trials were conducted with water and feed provided ad libitum and light was provided 23 h/day.

The three treatments had no significant effect on the incidence of celluli-

Key Words: Broiler chicken, ventilation rate, air speed, disturbance, temperature

149 Contrasting heat stress sensitivity in different broiler breeder lines. N.A. Gonet1, M.A. Mitchell1, D.A. Sandercock1, R.R. Hunter1, and A.J. Carlisle1, 1 Roslin Institute, Roslin, Midlothian, UK.

During commercial production broiler chickens may be exposed to elevated thermal loads inducing acute heat stress, for example, during transport from farms to slaughter. Under these conditions birds will experience transient hyperthermia and disturbances in acid-base balance associated with skeletal muscle damage and increased mortality. It is not known if genetic selection for increased growth rate and food conversion efficiency have influenced the susceptibility of broilers to such acute heat stress. The present study, therefore, has compared thermoregulatory success and effort in three grandparent broiler breeder lines (A, B and C) during exposure to acute heat stress (AHS). Ten 6 week old birds from each of the 3 lines were placed in simulated transportation conditions (30°C / 70% RH (AHS treatment) for 3 hours. Rectal temperatures were measured and venous blood samples taken before and after AHS and analysed for pCO2 and pH. The mean 6
week body weights for the three lines did not differ significantly. Under the heat load imposed during HS, all 3 lines exhibited significant hyperthermia ($p<0.001$) and hypocapnia ($p<0.01$) with a tendency towards an associated alkalosis. In response to the thermal challenge line A exhibited a more marked hyperthermia than the other 2 lines ($p<0.05$), line C exhibiting the smallest response. The largest disturbances in $pCO_2$ and $pH$ were observed in lines B and A ($p<0.05$) whilst line C exhibited only a mild hypocapnia and no significant alteration in $pH$. It may be concluded that line A is the most heat stress susceptible of the three and line C the most heat tolerant. Line C is better able to thermoregulate following exposure at the imposed heat load with an apparently reduced thermoregulatory effort. Lines used in the production of broilers possess different degrees of thermostolerance and this may contribute to the thermoregulatory capacities and characteristics of the commercial meat birds. These findings may have implications for future selection strategies.

**Key Words**: Broiler breeder, Thermoregulation, Stress

### 150 Effects of acute heat stress on indices of meat quality in different skeletal muscle types in broiler chickens. D.A. Sandercock, 1 N.A. Gone1, 1 R.R. Hunter, 1 P.M. Hocking, 1 and M.A. Mitchell, 1, 2 Roslin Institute, Roslin, Midlothian, UK.

Previous studies have demonstrated decrements in post-mortem breast meat quality in broiler chickens exposed to acute heat stress ($AHS$). These changes included lowered muscle pH immediately post-slaughter ($pH_i$) and elevated meat drip loss associated with increased rates of pre- and post-mortem glycolytic metabolism. It is not known if AHS affects skeletal muscle types in the same manner. This study therefore examined the effect of AHS on indices of meat quality in broiler muscles of differing metabolic characteristics (glycolytic vs. oxidative) in the breast (BM), thigh (TM) and drumstick (DM). Two groups of 12 male broilers (8 weeks) were exposed to AHS ($31^\circ C/75\%RH$) or control conditions ($21^\circ C/50\%RH$) for 8h in controlled climate chambers. Indices of thermoregulatory effort and success were measured to quantify the extent of the effect of the imposed heat load. Muscle pH, drip loss and colour were measured as indices of meat quality. Exposure to AHS produced a lower $pH_i$ in all muscles ($P<0.05$), this effect was greatest in BM. Muscle pH after 24h ($pH_u$) was lower in BM than in the other muscle types ($P<0.01$). Values for $pH_i$ were not affected by AHS in any of the muscle types. Drip losses were greatest in BM and were further elevated in this muscle by AHS exposure ($P<0.001$). AHS did not affect drip losses from TM and DM. Muscle lightness ($L^*$) values increased in BM ($P<0.001$) and decreased in TM ($P<0.01$) after AHS but did not alter in DM. Both BM and TM exhibited increases in redness ($a^*$) values ($P<0.05$) the extent of the increase being greater in the TM ($P<0.02$). Muscle yellowness ($b^*$) values decreased in BM and TM to a similar extent following AHS exposure ($P<0.05$). It is clear from this study that alterations in meat quality attributes induced by AHS are dependent upon muscle fibre type. Changes in meat pH, drip loss and colour appear to be greater in muscles which predominately function via glycolytic metabolism.

**Key Words**: Meat quality, Broiler, Heat stress, Glycolytic metabolism

### 151 An Automatic System to Properly Raise Nipple Watering Lines During a Full Broiler Rearing Period. J. D. Simmons1 and B. D. Lott1, 1 USDA-ARS South Central Poultry Research Laboratory.

Throughout the poultry industry, nipple watering lines have become common in broiler houses. Presently, growers use thumb rules or a yardstick type measuring device to aid in properly raising the nipple water lines as broilers grow. Every few days, the line has to be raised to keep the nipple just above the head of growing birds. This is done with a winch usually located on the ceiling and operated manually with a long hand crank. A system was developed at the South Central Poultry Research Laboratory which can raise the line automatically as the birds get larger. The system consisted of a switch located higher than the nipples and triggered by the birds themselves, an event counter, and an auxiliary winch mechanism to raise the watering line. When a sufficient number of counts indicated that the birds were tall enough to warrant a higher line position, the event counter activated the winch and raised the line to a predetermined, short distance. Repeated trials from day one to seven weeks of age revealed that the automatic system could keep the watering line to within 1.27 cm (0.5 in) of manufacturers recommendations. The system is described in detail and suggested parameters for operation are offered.

**Key Words**: Automatic, Waterer height, Broilers

### 152 Feed consumption, water consumption and lighting programs on a commercial broiler farm. M. P. Lacy and M. Czarick, The University of Georgia, Athens, GA.

Feed and water consumption were measured on a commercial broiler farm and related to restricted lighting typically used by broiler producers to slow early growth and thereby improve feed efficiency and reduce growth-related disease. Feed consumption was measured at daily intervals with load cells placed under all feed bin supports. Water consumption was measured every 15 min with standard water flow meters attached to the drinker system. In addition, temperature and humidity conditions inside the broiler house were recorded every 15 min, and birds were weighed continuously throughout the growout using computer controlled platform scales located in five areas in the broiler housing. Daily feed and water consumption were highly correlated ($r^2 = .987$). From one to fourteen days of age, water consumption averaged approximately 2.0 times feed consumption on a weight to weight basis. Over the life of the flock (42 days), water consumption averaged 1.5 times feed consumption. Chicks were started on 24 hours of light. The restricted lighting program (16 hours light:8 hours dark) was imposed on the birds beginning at 7 days of age. Feed and water consumption patterns were observed to be affected by the restricted lighting program. Feed and water consumption peaked just after lights were turned on each day. Within 3 to 5 days of the time the lighting program was first imposed, it appeared that the chicks learned to anticipate the daily initiation of the dark period, and feed and water consumption were observed to peak again just prior to lights off. This peak gradually disappeared when the lighting program was terminated and the broilers were returned to continuous light.

**Key Words**: Feed Consumption, Water Consumption, Restricted Lighting, Broilers

### 153 Broiler litter characteristics as influenced by dietary protein and amino acid supplementation. R.S. Gates, 1 A.J. Pescatore, 1 K.R. Liberty, 1 H.C. Cantor, 1 M.J. Ford, 1 D. Burnham, 2 and A.S. Hussein, 1 University of Kentucky, 2 Heartland Lysine, Inc., 3 United Arab Emirates University.

The effect of using four levels of CP with supplemental amino acids in iso-caloric broiler grower and finisher diets was evaluated for their impact on broiler litter characteristics. The four dietary levels of percent CP (grower, finisher) were: High (23, 22.5), M-Hi (20.8, 20), M-Low (18.5, 17.5) and Low (16.3, 15). Grower diets were fed from age 18d through 35d and finisher diets from 36d through 42d (trials 1 and 2) or 49d (trial 3). Three flocks of birds were raised, and in each trial there were 4 treatments x 12 replicate groups of 24 male chicks housed in floor pens for a total of 1152 birds per flock. Flock 1 commenced in June and Flock 3 was completed in December. Other than seasonal environmental changes the only difference between flocks was the re-use of litter. Litter characteristics measured included: surface equilibrium NH$_3$ concentration, surface and subsurface (at 2 cm) temperature, pH, moisture content and total ammoniacal nitrogen (TAN). For each flock, litter moisture content was generally quite low (25-40%) and was attributed to uniform minimum ventilation and nipple drinkers with limited waste. Equilibrium NH$_3$ was greatest for High CP diet and lowest for M-Low and Low CP in flocks 1 and 3 ($P<0.01$ and $P<0.001$, respectively). There was no measurable NH$_3$ during flock 2, when maximum ventilation rates were used during the entire growout period. Litter pH (mean of surface and subsurface samples) was highest for High CP and significantly lower for M-Low and Low diets for all three flocks; litter pH was lowest for all diets in flock 2. TAN was not affected by diet on new litter (flock 1), but was found to be significantly lower in M-Low and Low CP (flock 1 and 3 ($P<0.01$ and $P<0.001$, respectively). There was no measurable NH$_3$ during flock 2, when maximum ventilation rates were used during the entire growout period. Litter pH (mean of surface and subsurface samples) was highest for High CP and significantly lower for M-Low and Low diets for all three flocks; litter pH was lowest for all diets in flock 2. TAN was not affected by diet on new litter (flock 1), but was found to be significantly lower in M-Low and Low CP (flock 2), and M-High, M-Low and Low (flock 3) diets. Equilibrium NH$_3$ was influenced by TAN, pH and the product of TAN *10$^{-pH}$, and suggest that a 10% increase in litter pH and a 10% increase in TAN correlated with 11% and 33% increase in equilibrium NH$_3$. Results suggest that CP in excess of bird requirements substantially increases environment loading in terms of litter N and room NH$_3$ concentrations, and that ventilation plays an important role in reducing equilibrium NH$_3$ but not litter TAN. The use of twelve replicates per treatment was found necessary to separate means on the highly variable equilibrium NH$_3$ measurement.

**Key Words**: ammonia, broilers, litter, nitrogen, protein
154 Effects of density on the use of perches in broilers. Inma Estevez* and Rosemary Pettit, Animal and Avian Sciences, University of Maryland.

Exercise through perching has been suggested as a way to reduce the impact of leg problems in laying hens. However this would probably not be as effective in improving leg health in broilers due to their low frequency of use of perches. Despite of this, it is still possible that perching would increase at high rearing densities due to: reduced floor space availability, higher rate of disturbances among birds and/or social facilitation processes. If this is shown to occur, access to perches may be a way to reduce the impact of the detrimental effects of density in broiler health and performance, including improvement of leg condition. It was hypothesized that frequency of use of perches in broilers would linearly increase with increasing density for all perch treatments. To test this hypothesis 2424 mixed sex broilers were assigned to 36 pens in a 4 perch treatment x 3 density factorial (10, 15, and 20 birds/m²) with 3 replications for each treatment/density combination. The four perch treatments consisted of: three horizontal perches (horizontal treatment), three 10º angled perches (angled treatment), one horizontal, one 10º angled, and one 20º angled perch (mixed angle treatment), and no perches (control). Overall, perch use was low (2.6% ± 1.5%), but significant differences between perch treatments and densities were clear. Perching frequency was significantly higher when birds were raised at stocking densities of 15 birds/m² or above, as indicated by a marginally significant main effect (p<.0597), and a significant linear contrast (p<.0427). The birds used the perches within the horizontal, and angled perch treatments significantly more (p<.01) than those in mixed treatments. Age was found to have major effects on perching frequency (p<.0001) with higher use of perches during the first four weeks, and a significant reduction by the end of the rearing period. Contrary to expected, there was no significant interaction between density and age effects, suggesting that higher frequency of perch use may be due to social facilitation factors rather than to lack of space or higher level of disturbances among birds.

Key Words: Broiler, Perches, Density, Behavior

155 Identifying attractive pecking devices for domestic chicks: influence of colour and complexity. R.B. Jones*1, N.L. Carmichael1, and E. Rayner1, Roslin Institute (Edinburgh), Roslin, Midlothian, Scotland.

Environmental enrichment can improve poultry welfare and productivity. Enrichment devices would likely be more effective if they sustained the birds’ interest but many have failed to do so. This may reflect the fact that the choice of stimuli reflects human preconceptions rather than a critical consideration of chickens’ preferences and predispositions. Jones and Carmichael (1998, 1999) identified string as an extremely attractive stimulus for chicks and adults of a laying strain (ISA Brown). Here, at 5 days of age, various devices were placed simultaneously in the home cages of pairs of Lohmann Brown chicks for 10 min a day on 5 consecutive days. These chicks also pecked sooner at a bunch of string than at lengths of beads or chains. White or yellow strings were preferred to red, green or blue ones and white string attracted more pecking than combinations of white and yellow or of all five colours. Though the literature suggests that small, spherical, shiny beads should be particularly attractive, incorporating such stimuli in the white string devices actually reduced pecking. All the devices elicited increasing interest with repeated presentation; this trend was particularly marked for white string. Clearly, young chicks of at least two strains exhibit specific and similar pecking preferences. White string is a very attractive stimulus and simple devices are preferred to more complex ones.

Key Words: Chickens, Environmental enrichment, Pecking devices, Pecking preferences

156 The effect of different *E. coli* isolates on inducing avian cellulitis lesions in MHC defined broiler chickens. K.S. Macklin, R.A. Norton, and S.J. Ewald, Auburn University, Auburn, AL.

Previous work in this lab, using an avian cellulitis origin *E. coli* isolate (EC1) demonstrated that the MHC (B type) effects lesion formation, specifically that B13 was resistant while B32 was susceptible. An other study, utilizing four other cellulitis origin *E. coli* at the same dose (~x10⁶ cfu) and in the same MHC type birds, implied the MHC effect was unique to EC1. It is speculated the difference observed between EC1 and the other four isolates may be due to differences in as yet unidentified pathogenicity factors. Pathogenicity differences among isolates were manifested as variations in the lesion formation (cellulitis lesions were 1.5 and 2.0 cm respectively). Lesion formation was analyzed to specifically determine if MHC effects lesion formation. Recent primer sets for PCR analysis of chicken IL-1, IL-2, INFγ, TGFβ and TGFβ3 have been developed. Therefore, the present study examined in *vivo* effects of dietary PUFA and an inflammatory challenge with *Salmonella typhimurium* LPS on cellulitis profiles in growing layer hens. Two hundred and forty 4-d-old layer pullets were housed in battery cages with 5 pullets per pen. A 2 x 4 factorial design of treatments, with LPS and diet as factors, was used. Birds were injected i.v. with either 1 mg *S. typhimurium* LPS in 1 mL saline or 1 mL saline, which served as a control. The experimental diets consisted of a constant fraction of 95% of basal diet, and a varying 5% oil fraction. The four oils used were: corn oil, linseed oil, menhaden oil, and tallow. At 37 or 38 d of age the birds were injected with treatments and 4 pullets per pen were killed 2 hrs later and spleens were removed. RNA was extracted from individual spleens and then pooled within pens prior to reverse transcription. The resulting cDNA was used for polymerase chain reaction with primer sets for chicken IL-1, IL-2, INFγ, TGFβ, and TGFβ3 as internal controls. The relative expression of each cytokine was measured using the qPCR. A significant effect of LPS on TGFβ3 expression. No effects of dietary PUFA or interactions between LPS and dietary PUFA were found. The present experiment shows that in vivo effects of immune challenge on mRNA expression for cytokine synthesis can be measured, but as yet no effects of dietary PUFA on cytokine synthesis were established.

Key Words: MHC, Cellulitis, Broiler, *E. coli*

157 *Salmonella typhimurium* LPS increases in *vivo* splenic IL-1, IL-2, and INFγ mRNA expression in laying hens. J. W. C. Sijben*1 and K. C. Klassing2, Wageningen University, Wageningen, The Netherlands, 2 University of California, Davis CA, USA.

Much of the interest in nutrition and immunity has focused on polyunsaturated fatty acids (PUFA). Effects of dietary PUFA on several immunological parameters have been reported. However, effects on the underlying regulating mechanisms, i.e., cytokine profiles, have never been extensively described in poultry because the necessary assays were lacking. Recently primer sets for PCR analysis of chicken IL-1, IL-2, INFγ, and TGFβ have been developed. Therefore, the present study examined in *vivo* effects of dietary PUFA and an inflammatory challenge with *Salmonella typhimurium* LPS on cytokine profiles in growing layer hens. Two hundred and forty 4-d-old layer pullets were housed in battery cages with 5 pullets per pen. A 2 x 4 factorial design of treatments, with LPS and diet as factors, was used. Birds were injected i.v. with either 1 mg *S. typhimurium* LPS in 1 mL saline or 1 mL saline, which served as a control. The experimental diets consisted of a constant fraction of 95% of basal diet, and a varying 5% oil fraction. The four oils used were: corn oil, linseed oil, menhaden oil, and tallow. At 37 or 38 d of age the birds were injected with treatments and 4 pullets per pen were killed 2 hrs later and spleens were removed. RNA was extracted from individual spleens and then pooled within pens prior to reverse transcription. The resulting cDNA was used for polymerase chain reaction with primer sets for chicken IL-1, IL-2, INFγ, TGFβ, and β-actin as internal control. The relative expression of each cytokine was measured using the qPCR. A significant effect of LPS on TGFβ3 expression. No effects of dietary PUFA or interactions between LPS and dietary PUFA were found. The present experiment shows that in vivo effects of immune challenge on mRNA expression for cytokine synthesis can be measured, but as yet no effects of dietary PUFA on cytokine synthesis were established.

Key Words: cytokines, LPS, polyunsaturated fatty acids, layers