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185 Omega-3 PUFA and lutein enrichment: Different feeding strategies and effect on storage stability. S. Nain* and R. A. Renema, *University of Alberta, Edmonton, AB, Canada.*

Enrichment diets high in ground flax may cause irritation to the gut, which may affect absorption of omega-3 polyunsaturated fatty acids (ω -3 PUFA) from flax as well as other dietary enrichment ingredients. This study assessed the egg enrichment with ω -3 PUFA and Lutein when provided alone in the diet, in combination, or when fed in alternate day patterns. A total of 144 individually caged Lohman White Leghorn layers (56 wk) were fed 1 of 6 diets balanced for energy and protein for 60d as follows: Control (C) = Standard hen ration; Lutein (L) = 500 ppm lutein; Flax (F) = 10% flaxseed; Lutein/Flax mix (LF); Alternating L and F diets every day (Alt1) or second day (Alt2). Egg traits were determined and yolks collected at 0d, 14d, 28d and 56d. Eggs from 57d were stored at 4 C for 30d for assessment of oxidative stability through TBARS analysis. Data were analyzed using proc Mixed of SAS. Hen diet did not affect egg production, egg weight, albumin height or shell thickness. Although, absolute yolk weight was higher in birds on C diet as compare to other diets, but % yolk weights were similar. Total ω -3 PUFA in LF and F eggs averaged 13.9 mg/g yolk compared to 11.6 mg/g yolk in Alt1 and Alt 2 eggs and 8.8 mg/g in L and C diets. Lutein followed a similar enrichment pattern, with birds fed L or LF having the highest egg content (25.7 μ g/g yolk). While L and LF eggs had 3-fold more lutein than C or F eggs (8.4 μ g/g), those from alternate day fed hens had 2-fold more lutein. Including both flax and lutein in the hen ration did not reduce egg lutein enrichment. Inclusion of lutein generated the lowest TBARS values (0.60 mg/MDA in L and LF) compared to diets without lutein (0.75 mg/MDA in C and F), demonstrating a potential antioxidant role in the egg. Yolk lutein concentration was positively correlated to canthaxanthin ($r=0.65$, $P<.0001$) and β -carotene ($r=0.40$, $P<.0001$). Egg storage did not affect yolk lutein and β -carotene amount, whereas canthaxanthin was reduced. Lutein enrichment improves the overall carotenoid profile and also enhances stability during storage of egg, and was not negatively affected by ω -3 PUFA enrichment using flaxseed.

Key Words: lutein, ω -3 PUFA, TBARS

186 Effect of egg storage conditions on gene expression during turkey embryonic development. J. A. Hamidu*¹, M. Li¹, G. M. Fasenko², and L. L. Guan¹, ¹*University of Alberta, Edmonton, Alberta, Canada*, ²*University of New Mexico, Albuquerque.*

Different conditions of avian egg storage before incubation are known to cause variation in embryonic mortality in poultry species. We hypothesized that genes regulating apoptosis (*Bcl-2*, *Bcl-xL*, *Bax*, *Bak* and *Bok*) or early embryo development (*Btg1*) could be differentially expressed under different storage conditions which may play a role to control turkey embryonic development. In this study, eggs from Hybrid turkey flocks were stored for 4 d and 14 d under standard storage conditions. Total RNA was extracted from pooled embryo samples ($n = 5$ per treatment) after incubating the eggs for 6 d at 37.5°C and 56% RH. The expression levels of *Bcl-2*, *Bcl-xL*, *Bax*, *Bak*, *Bok* and *Btg1* genes were compared using quantitative real time PCR analysis. The data was analyzed by PROC MIXED model procedure of SAS at $P \leq 0.05$. LSmean differences between egg storage treatments were separated by PDIFF. The results showed that the genes associated with pro-apoptotic processes were differentially expressed in 14 d vs. 4 d egg storage treatment: *Bax* and *Bok* were upregulated (*Bax*, 1.71 fold, $P = 0.0428$; *Bok*, 1.39 fold,

$P = 0.007$) while *Bak* was downregulated but not significant (0.37 fold, $P = 0.0628$). Moreover, the genes associated with anti-apoptotic events were upregulated (*Bcl-2*, 1.34 fold, $P = 0.3026$; *Bcl-xL*, 1.23 fold, $P = 0.0003$). However, the expression of *Bcl-2* was not statistically different between treatments. These genes were identified to be involved in different KEGG pathways of apoptosis: mitochondrial pathway or p53 pathway. The *Btg1* gene, was also downregulated following egg storage for 14 d compared with 4 d (0.54 fold, $P = 0.0150$). Our findings demonstrate increased expression of apoptosis events and decreased response to growth and development at the molecular level following egg storage for 14 d. This study shows that the probability to control some of the effects of egg storage commercially is promising if apoptosis can be controlled.

Key Words: egg storage, RNA, gene expression

187 Body weight change, breast muscle, and reproductive tract development in broiler breeder hens and their effects on fertility and egg production. N. Lekrisompong*, J. T. Brake, and E. O. Oviedo-Rondon, *North Carolina State University, Department of Poultry Science, Scott Hall, Raleigh.*

A study was conducted to determine the effects of the relationship among changes in BW gain, breast muscle, and reproductive tract development in broiler breeder females. Pullets were reared in 16 litter floor pens from hatching to 22 wk of age. Females that represented the BW distribution of each pen were selected and moved at 22 wk to 128 individual cages. Individual BW was taken at 22, 25, 26, 33, 48, and 53 wk of age. BW change between each period was determined. Breast muscle weight was estimated in vivo with real-time ultrasound (RTU) at 25, 26, 48, and 53 wk. A multiple linear regression equation that included BW, area of breast muscle (BM) taken by RTU and strain was estimated. Fertility was measured at 31 and 48 wk. Total egg production per hen was recorded. At 53 wk, all hens were necropsied to determine weights of BM, ovary, and oviduct segments. Results indicated that RTU can be used to estimate BM weight ($r^2 = 0.91$) in broiler breeders. It was found that BW change between 22 to 26 wk was positively correlated with BM weight ($r = 0.70$), but negatively correlated with total egg production ($r = 0.37$). Breast muscle at any age was negatively correlated with infundibulum ($r = 0.25$) and with total egg production ($r = 0.26$). Breast muscle was also negatively correlated with fertility when evaluated at 31 wk, but not at 48 wk. Changes in BW in time periods other than 22 to 26 wk were not correlated with total egg production or fertility. It would appear that, in the presence of excess feed between 22 and 26 wk, hens developed their breast muscle at the expense of their infundibulum, and this may affect fertility, and total egg production.

Key Words: real-time ultrasound, broiler breeder, oviduct

188 Effects of temperature on egg size and quality. A. G. C. DesLauriers*, M. J. Zuidhof, R. A. Renema, D. Paul, and A. Pishnamazi, *University of Alberta, Edmonton, Alberta, Canada.*

Environmental temperature has a large impact on broiler breeder maintenance requirements. Energy for maintenance accounts for up to 3/4 of total energy intake. Therefore incremental changes in maintenance requirements may substantially influence energy available for other processes such as growth or egg production. Thus temperature is important for egg production, egg size and chick size. An experiment was conducted to determine the effect of temperature on egg size and

quality. A total of 192 individually caged broiler breeders were exposed to differing environmental temperature treatments (15, 19, 23, and 27°C). The treatments were randomly assigned to 6 individual environmental chambers for 2 week periods, with 15 replicates of each temperature treatment over a 20 week trial period. All eggs were collected, weighed and graded daily. Temperatures were recorded using automated data loggers positioned at bird head height, on a 30 min interval and were averaged for the 24 hour period prior to oviposition. Data were analyzed as a 2 way ANOVA using the mixed procedure of SAS. Significant differences were reported at $P < 0.05$. Egg size increased from an average of 57.5 ± 0.24 g in the 15°C treatment with each increasing temperature trial up to 23°C (60.0 ± 0.24 g); a further temperature increase to 27°C resulted in a drop in egg size (58.0 ± 0.24 g), presumably due to heat stress. Temperature was found to have a significant effect on production of grade A eggs with the highest percent of grade A's in the 19°C and 23°C treatment. The 27°C treatment had the lowest percentage of grade A eggs and the highest incidence of soft shelled eggs. Shellless eggs were also highest in the 27°C treatment ($0.708 \pm 0.123\%$) although not significantly different from the 19°C treatment. The 15°C treatment had the lowest incidence of misshapen shells ($0.302 \pm 0.252\%$). Overall the data suggested that maintenance energy requirements increased with decreasing environmental temperatures and at the highest environmental temperature tested, there was indirect evidence of metabolic stress (reduced egg size and quality).

Key Words: temperature, egg size, egg quality

189 The impact of distillers dried grains plus solubles (DDGS) diets on hen performance, egg quality, and manure nutrients. P. H. Patterson, A. Y. Pekel, A. Adrizal, H. K. Burley*, T. L. Cravener, E. F. Wheeler, and P. A. Topper, *The Pennsylvania State University, University Park.*

Diets including 10% DDGS with (D+P) or without (D) the probiotic Provalen (500g/1000kg) were compared with a corn-soybean based control diet (CON) in a commercial hen house. Three groups of 39,800 Lohmann LSL-Lite hens were fed isocaloric, amino acid balanced research diets from 20 to 65 wk of age with 2 of 6 rows of stacked cages with manure belts assigned randomly per diet. Replicated monthly data, including hen body wt (BW), egg production (EP) and weight (EW), albumen height (AH), Haugh units (HU), yolk color (YC), and shell strength (SS) and thickness (ST), was collected from 558 hens in a section of each cage row. Feed/water intake, BW, EP, case weight, mortality, feed cost (FC), and egg income (EI) was also tallied weekly by the egg company for each diet. Monthly samples of fresh manure were taken off the manure belts (6/treatment) and from the manure storage building (2/treatment) and analyzed for moisture and agronomic nutrients. Statistical analysis was done with SAS version 9.1 using Tukey's mean comparisons with $P \leq 0.05$ deemed significant. Diet did not significantly impact BW, EW, HU, SS, or ST ($P > 0.05$); however, CON hens had lower EP, AH, and YC than D and D+P hens ($P \leq 0.05$). Manure moisture, total nitrogen (N), ammonium-N ($\text{NH}_4\text{-N}$), organic-N, and total potash (K_2O) did not differ significantly by diet, although manure total phosphorus (P_2O_5) was higher for CON samples ($P < 0.05$). Stored manure samples from CON had greater moisture and less $\text{NH}_4\text{-N}$ than samples from D and D+P hens ($P < 0.10$). Weekly company data summarized for the entire study showed that EP averaged 85.8, 85.2, 85.7% and total eggs per hen housed at 65 wk of age were 271, 270 and 271 for CON, D, and D+P diets, respectively. Mean feed intake and feed conversion were 100.0, 100.0, and 104.3 g/hen/d and 1.91, 1.95, 1.95 kg feed/dozen eggs for the CON, D, and D+P diets, respectively. Weekly EI from selling eggs to the breaker market averaged \$12,851, \$12,801, and \$12,864,

weekly FC averaged \$6,705, \$6,599, and \$6,671, and, therefore, weekly EI minus FC (e.g., farm revenue) averaged \$6,146, \$6,215, and \$6,209 for CON, D, and D+P diets, respectively.

Key Words: distillers grains, hen performance, manure

190 Breeder hen age affects chick early innate immune function. M. L. Johnson* and D. R. Korver, *University of Alberta, Edmonton, Canada.*

Newly hatched broiler chicks do not possess a well-developed acquired immune system, therefore they rely to a large extent on innate immunity. As hens age, chick quality is usually considered to increase, however this is typically assessed on physical parameters such as chick weight and body length, rather than on disease resistance. The objective of this study was to examine the effects of broiler breeder hen age on innate immune function in young broilers. Hens were fed a commercial-type diet and fertile eggs were collected and incubated weekly at 3 hen ages: Early (30–33), Mid (44–47) and Late (57–59) wk of hen age. Hen body weight, settable egg production, hatchability, chick body weight at hatch were assessed. Whole blood was collected from chicks at 1 and 4 d of age to assess the ability of chick lymphocytes to kill *Escherichia coli* in vitro. Data were analyzed as a mixed model ANOVA in SAS. Differences were considered significant at $P \leq 0.05$. Hen body weight increased by 12% and settable egg production decreased by 38% from Early to Late production. Hatchability during the Late period was 11 and 9% lower than the Early and Mid periods, respectively. Hen fertility decreased from Mid to Late production. Chick body weight at hatch increased by 21% between the Early and Late production periods. At the Early hen age, the bactericidal activity of chick immune cells increased by 27% between 1 and 4 days of age; there were no chick age-related differences in bactericidal activity at either Mid or Late hen ages. At d 1, chick immune cell bactericidal activity at the Early hen age was 4.6- and 16.1-fold greater than at the Mid and Late breeder age, respectively; at d 4, bactericidal activity at the Early hen age were 3.4- and 4.8-fold greater than at the Mid and Late hen ages, respectively. At the Mid and Late hen ages, chick immune cell bactericidal activities were not different from each other at either chick age. As hens age, chick hatch weight increases, but chick innate immune cell bactericidal activity is greatest when hens are at the early stages of the production cycle.

Key Words: broiler breeder age, innate immunity, chick quality

191 Sperm production and testicular development of broiler breeder males reared on shortened growth cycles. J. R. Moyle*, S. M. Whipple, D. E. Yohoo, and R. K. Bramwell, *University of Arkansas, Fayetteville.*

Feed restriction is an important tool used in the rearing of broiler breeds to control growth and maintain body weight. Feed restriction during the growing phase is typically 60–80% less than what birds would eat ad libitum, resulting in a perceived animal welfare issue. Because males are typically more severely feed restricted than females, this is perceived to be especially stressful to the growing cockerels. During this time the reproductive systems of the males are going through formative stages and improper management can have lifelong effects on their reproductive performance. Therefore, the objective of this study was to raise males under feed management programs that would require less severe feed restriction while still rearing replacement breeder males to the recommended target body weight of 3.060kg at 12, 15, 18, 21 and 24 wks of age, respectively. Males were placed at 3 wk intervals so that all males were light stimulated at the same time but at different ages with the same body weight. There were a total of 5 treatment groups based

on the age of the male at the time of light simulation. All males were reared in the same light controlled house at the University of Arkansas Research Farm. Males were light stimulated and testes development, semen analysis, fertility and mating activity were recorded for each group of males. To measure semen production, males were housed in individual cages, with 24 males from each treatment tested. All data were analyzed using ANOVA and means were considered significantly different when P values were less than 0.05. Results found that males lit at 18 wks of age had the highest semen volume (0.46mL) followed by males lit at 24 (0.31mL), 15 (0.29mL), 21(0.27mL) and 12 wks (0.27mL), respectively. Sperm count per ejaculate was highest for the males lit at 18 wks of age followed by males lit at 21, 24, 15, and 12 wks, respectively. Males that were 21 wks or older at the time of lighting responded quicker to light stimulation than did younger males.

Key Words: broiler breeder, sperm production, lighting

192 Germination of *Bacillus subtilis* C-3102 in the gut of conventional and germ-free chicken. T. Hamaoka^{*1}, N. Otomo¹, B. Y. Lee¹, Y. Tadano², T. Marubashi², J. Marshall³, and A. Van Kessel³, ¹*Calpis U.S.A., Inc., Mt. Prospect, IL*, ²*Calpis co. Ltd., Tokyo, Japan*, ³*University of Saskatchewan, Saskatchewan, Canada*.

Bacillus subtilis C-3102(BSC) is utilized in a probiotic product Calsporin (Calpis Co. Ltd., Japan) and made available worldwide. Shifts in intestinal microbial colonization patterns are observed when there is an improvement in production performance by BSC. To determine the mechanism of action of BSC, we have conducted 2 trials to investigate the germination of BSC spores in gastrointestinal tract of conventional and ex-germfree monoassociated chickens. Ten 28-d old conventional broilers (Cobb) were assigned to individual cages. A corn-soybean based diet was fed with 3.0×10^5 CFU/g of BSC spores. At the age of 55-d, 10 birds were killed to collect gut contents from crop, gizzard, jejunum, ileum, cecum and feces. Samples were diluted and plated directly to enumerate spores plus vegetative cells (total count). Remaining sample was heat treated (60°C for 30min) and plated again to enumerate spores. The total count (log CFU/g) of BSC at each gut location ranged from 4.85 to 5.47 and was not different. Spore ratio was 61% and 95% of total count in gizzard and cecum, respectively, suggesting germination of spores at these locations. Germ-free chickens (Ross308) were reared in HEPA-filtered sterilized isolators by methods developed at the University of Saskatchewan. Chicks were fed *ad libitum* a gamma irradiated corn-soybean diet supplemented with 3×10^5 CFU/g of BSC spores. At 14-d of age, 10 birds were killed and intestinal contents were collected for enumeration of BSC as above. The total count (log CFU/g) increased ($P < 0.05$) from 5.78 in crop to 7.16 in cecum. The spore ratio ranged from 59.2% to 82% of total count and is consistent with the conventional birds which showed lower ratio in gizzard (68.5%) and cecum (59.2%). We conclude that BSC spores germinate in the chicken gastrointestinal tract, primarily in gizzard and cecum.

Key Words: *Bacillus subtilis*C-3102, Calsporin, germ-free

193 Examining the sitter duck condition. K. Murdoch¹, K. Seward¹, J. Riley¹, D. T. Ort², and M. J. Wineland^{*2}, ¹*Maple Leaf Farms, Milford, IN*, ²*North Carolina State University, Raleigh*.

The sitter duck condition observed in the duck industry can cause downgrading at the plant. During the loading and unloading process of driving the ducks onto and off the truck some ducks would sit and not continue walking the ramp during the process resulting in the following ducks stepping over and on the sitter ducks causing scratches which results in downgrading of the carcasses. Observations were made pertaining to

level on truck transport, duration of transport. Ducklings were evaluated at unloading at the plant for 2 trials. Thirteen blood parameters were measured using an i-Stat Analyzer in both trials. Additionally in the second trial CK and LDH were determined. Parameters were evaluated by condition of sitter or normal and by sex of bird in trial 1. In trial 2, sitter and normal ducklings were evaluated on 6 farms, and on 2 of these farms the initially sampled ducklings were evaluated 24 h later after being held in the holding pen with feed and water. Data was analyzed in a factorial design using GLM Procedure of SAS. Sitter ducks were more prevalent when transported on the upper levels of the transport truck where they were required to walk a steeper incline at loading and unloading. In the first trial sitter ducks demonstrated significantly elevated pCO₂, Na⁺ (30.97 versus 29.41) and (141.27 versus 138.45) respectively and significantly lower K⁺ (4.10 versus 4.23). In the second trial Na⁺, glucose and ionized Ca was significantly elevated. Approaching significance was K⁺ where it was lower in the sitter than the normal duckling. CK and LDH was significantly greater in the sitter ducks than the normal ducklings (3913 versus 2506 and 861 versus 444 respectively). Ducklings which were evaluated at unloading and then again 24 h later in the holding pen demonstrated a reduction in the sitter duckling to levels comparable to the normal duckling. Evidence suggests that the sitter condition is related to exertion and ramp slope during unloading. Additionally tissue damage is indicated by the elevated CK and LDH as well as the elevated plasma Na⁺ and decreased K⁺ levels.

Key Words: duckling, immobility, blood parameters

194 The effects of body weight on production and overall fertility and duration of fertility in broiler breeder hens. R. K. Bramwell*, D. E. Yoho, J. R. Moyle, and S. M. Whipple, *Department of Poultry Science, University of Arkansas, Fayetteville*.

Evaluating fertility problems in commercial broiler breeder flocks has traditional been targeted at the management and well being of the male. However, previous research has shown variation in the ability of individual broiler breeder hens within a flock to become fertilized. This variability is consistent with specific hens throughout their reproductive life and may or may not be related to age or body weight. This study was designed to evaluate the physiological capacity of broiler breeder hens to become fertilized under conditions of age and body weight. Two hundred pullets from each of 4 broiler breeder hen strains of were obtained from a commercial hatchery and reared into production according to industry standards. At 21 wks of age, birds were light stimulated and separated into one of 2 groups; either at or below target weight (C), or heavy or above target weight (H) and housed in individual cages. H birds were maintained at +300 g as compared with the C group until 60 wks of age. At 30 wks of age, hens were artificially inseminated with 100 million spermatozoa in a 0.05cc volume from a pooled semen sample. Inseminations continued at 5 wk intervals until 60 wks of age. All eggs were collected daily to determine fertility by day and week post-insemination. Values were analyzed by breeder hen strain and body weight group for 3 wks following each single insemination with all fertility values calculated from the single insemination until fertility ceased. Data were analyzed using JMP statistical software using ANOVA with means compared using the LSD method with significance determined when $P < 0.05$. Results from this trial indicate that the C groups had higher weekly egg production values as compared with the corresponding H groups. While fertility varied by age, the C group had consistently better fertility (48.5% and 40.0% life of flock fertility) and average duration of fertility (16.70 and 14.71 d) as compared with the H groups, respectively. Results indicate that body weight has a significantly

detrimental effect on fertility values and duration of fertility in most breeder hen strains regardless of age.

Key Words: broiler breeder, fertility, reproduction

195 Comparing the physiological capacity for fertility in caged broiler breeder hens from four commercial strains. R. K. Bramwell*, J. R. Moyle, S. M. Whipple, and D. E. Yoho, *Department of Poultry Science, University of Arkansas, Fayetteville.*

Maintaining fertility in commercial broiler breeder flocks, along with egg production, is one of the critical factors and goals of the breeder manager. However, previous research has shown genetic variability of broiler breeder hen strains to all reproductive characteristics. This variability may be consistent with hen strains, particularly yield type strains, but can often be altered with management programs. This study was designed to evaluate the physiological capacity of different strains of broiler breeder hens to become fertilized using artificial insemination, therefore eliminating natural mating and male libido effects. Two hundred pullets from each strain of broiler breeders were obtained from a commercial hatchery and reared into production according to industry standards. At 21 wks of age, birds were light stimulated and 100 hens per strain were separated into blocks of 10 individually caged hens with 10 replicate blocks per strain. Additional hens were housed in floor pens and were used to replace caged hens that had died or ceased egg production during the trial. At 30 wks of age all caged hens were artificially inseminated with 100 million sperm in a 0.05cc volume from a pooled semen sample. Inseminations continued at 5 wk intervals until 60 wks of age. All eggs were recorded and collected daily to determine fertility by day post-insemination. Values were analyzed by hen strain until the cessation of sperm activity was determined. Data were analyzed using JMP statistical software using ANOVA with means compared using the LSD method with significance determined when $P < 0.05$. Results indicate that while each hen strain varied in overall fertility following the single inseminations (from 42.7 to 46.1%), age had little effect on these hens (low of 38.4 and a high of 49.8%). There was no difference in overall duration of fertility for any of the hen strains with all strains averaging a duration of fertility between 15.6 and 15.8 d post-insemi-

nation. Results indicate that when hens are caged and natural mating factors are eliminated, fertility values are very similar for the 4 hen strains included in this study.

Key Words: broiler breeder, fertility, reproduction

196 Modeling energy utilization of broiler breeder hens is affected by environmental temperature and dietary energy. A. Pishnamazi*, M. J. Zuidhof, R. A. Renema, and D. Paul, *University of Alberta, Edmonton, Alberta, Canada.*

The accurate prediction of energy requirement affects the effectiveness of feed allocation decisions. This analysis was conducted to identify a model to estimate partial coefficients of ME partitioning of broiler breeder (BB) hens. A total of 288 hens (Ross 708) were individually caged in 1 of 6 environmentally controlled chambers at 21 wk. Ten, 2-wk temperature treatments were imposed from 21 to 41 wk, with 4 randomly rotating temperature treatments (15, 19, 23, and 27 C). Birds in each chamber were fed either a High Energy (HE, 2900 kcal/kg) or a Low Energy (LE, 2700 kcal/kg) diet. An energy utilization model was used to account for average daily ME intake twice/wk and calculate maintenance energy requirements (MEM). This model used a metabolic BW coefficient of 0.67. The nonlinear mixed model employed a normally distributed term associated with hen metabolic BW, and exponential terms of average daily gain (ADG), egg mass (EM) and temperature. The MEM at 21 C was 159.38 kcal/kg^{0.67}, with a temperature adjustment of -0.2995 kcal/C. The ME requirement for gain was 0.4013 kcal/g, with a temperature adjustment of -0.0234 and EM was 0.6183 kcal/g. According to this model, a broiler breeder hen weighing 3.0 kg, gaining 15g/d and producing 60g egg/d require 382, 376, or 369 kcal/d at 15, 21, and 28 C, respectively. This translates to 136.4, 134.3, or 131.8 g/d of 2,800 kcal ME/kg feed, respectively. Birds fed HE had a higher ADG coefficient than birds on the LE diet. However, both MEM and EM coefficients did not differ. The greatest impact of temperature is on MEM, whereas dietary energy affected growth.

Key Words: energy requirements, broiler breeders, environmental temperature