146 Effect of fat source and levels, with lysophospholipids, on broiler performance, fatty acid digestibility and apparent metabolizable energy content in feed. B. K. Zhang*[1], H. T. Li[2], Y. M. Guo[1], and D. Q. Zhao[1], [1]*China Agricultural University*, *Beijing, China*, [2]*Kemin Industries Co. Ltd*, *Zhuhai, China*.

Three fat sources (soybean oil, tallow, and poultry fat), at 2 levels of addition (24 or 30 g/kg diet) with or without a lysophospholipid emulsifier (0 or 500 mg/kg) were incorporated into broiler feed. A total of 504 one day-old male Arbor Acres broiler chickens were randomly allocated to 12 treatments with 7 replicates of 6 birds each. The experimental period lasted 21 d. The lysophospholipid emulsifier (LPL) was a commercial powder preparation mainly containing lysophosphatidylcholine. The performance of the broilers, fatty acid digestibility and apparent metabolizable energy (AME) of the feed was studied. The source of fat had a clear effect ($P < 0.01$) on body weight gain and feed conversion ratio. Body weight gain was lower ($P < 0.01$) for broilers fed diets containing tallow than for those fed diets containing soybean oil or poultry fat. Levels of fat addition did not significantly influence the body weight gain of broilers. The addition of LPL increased the body weight gain of broilers ($P = 0.030$) and also increased the AME ($P < 0.05$) and AMEn ($P < 0.05$) of the diets. The LPL enhanced body weight gain for chickens fed the poultry fat diet (563 g vs. 539.5 g), and to a lesser extent with the tallow diet (532.5 vs. 514.5 g), but not for the birds given the soybean oil diet. The sources of fat had a clear effect ($P < 0.01$) on the digestibility of most fatty acids. Addition of LPL increased digestibility of C16:0, and C18:0 fatty acids in the starter period ($P < 0.05$), but had no effect on the digestibility of the other fatty acids under the conditions tested. The AME and AMEn of the diets were not significantly affected by sources of fat ($P > 0.05$), but were significantly improved by LPL ($P < 0.05$). The digestibility of CP and DM were not affected ($P > 0.05$) by LPL, fat sources or the levels of fat addition. There was no significant interaction between growth parameters, digestibility and AME of the diets ($P > 0.05$). These data indicated that the effect of LPL on broiler performance was dependent upon the types of dietary fat.

Key Words: lysophospholipids, fats, broiler

147 Effect of dietary fat on the production and composition of emu oil. D. C. Bennett*, W. E. Code, and K. M. Cheng, *University of British Columbia*, *Vancouver, BC, Canada*.

Emus (*Dromaius novaehollandiae*) are large flightless birds that are farmed for their meat and fat. The fat from both the subcutaneous and retroperitoneal adipose depots is rendered into oil, which is purported to have anti-inflammatory and anti-oxidant properties. Dietary fatty acid composition influences the fatty acid composition of the oil, but its affect on fat deposition or on the amount of oil produced after rendering has not been reported. Work on broiler chickens has shown that dietary fatty acid composition influences both the accumulation and fatty acid composition of abdominal fat. Therefore, the objective of the present study is to examine the effect of 2 dietary sources of fat on the amount and fatty acid composition of emu oil. Forty 3-year-old emus were fed a barley-alfalfa base diet that was supplemented with either tallow or canola oil at 2 levels (4% or 8%; 5 males and 5 females per dietary group); an additional 10 birds (5 males and 5 females) remained on the barley-alfalfa diet as controls. Birds were fed these diets for 6 mo before being slaughtered in October. Body weight and meat and fat yields were unaffected by the diet and averaged 44.2, 14.1 and 9.7 kg/bird, respectively. Females weighed more than males (45.6 and 42.9 kg, respectively), but fat yield did not differ between the sexes (9.4 and 10.0 kg/bird, respectively). Similarly, diet did not affect the total amount of oil produced after rendering, which averaged 6.8 kg/bird. Analysis of fatty composition of the oil is currently underway. These results indicate that, unlike chickens, neither the source nor the level of fat in the diet affected the amount of fat deposition in emus.

Key Words: emu, fat production, dietary fat

148 Whole body retention of highly unsaturated n-3 fatty acids (HUFA) and apparent conversion from 18:3n-3 are independent of body weight in pigs fed flaxseed diets. H. R. Martínez Ramírez*[1], J. K. G. Kramer[2], and C. F. M. de Lange[1], [1]*Centre for Nutritional Modeling, Department of Animal and Poultry Science, University of Guelph*, *Guelph, ON, Canada, N1G2W1*, [2]*Agriculture and Agri-Food Canada*, *Guelph, ON, Canada, N1G5C9*.

A total of 28 Yorkshire growing gilts were used in a serial slaughter study to determine the content of n-3 fatty acid (FA) and the apparent conversion (AC) of 18:3n-3 to HUFAs (18:4n-3, 20:3n-3, 20:5n-3, 22:5n-3, 22:6n-3) on a whole body basis, fed 3 feeding programs (n = 8). Four pigs were slaughtered at 25 kg BW to determine initial body composition. Corn-wheat-soy based diets were fed to growing gilts containing ground flaxseed (FS): T1, FS diet (10%) between 25 and 50 kg BW, and control diets (C, low in n-3 FA) thereafter until 110 kg BW; T2, C between 25 and 85 kg BW, and FS diet (6%) thereafter until 110 kg BW; and T3, C between 25 and 110 kg BW. Feed intake was fixed at 95% of the voluntary feed intake according to NRC (1998). Pigs on T1 and T2 consumed equal amounts of FS (5.1 vs. 5.2 kg, $P > 0.10$). The FA content in whole body was expressed as mg/100 g of empty BW. No treatment effect was observed for growth performance, composition of growth, and chemical and physical body composition across treatments ($P > 0.05$). Contents of 18:3n-3 and HUFA were larger in T1 and T2 than T3 ($P < 0.05$), except for 22:6n-3. Content of 18:3n-3 was lower in T1 than T2 (522 vs. 611; $P < 0.01$), whereas no such effect was observed for either total HUFA (136 vs. 140; $P > 0.10$) or n-6/n-3 ratio (4.5 vs. 4.0; $P > 0.10$). Expressed as a portion of 18:3n-3 intake, the largest AC among n-3 FA in T1 and T2 was to 20:3n-3 (9.1 vs. 10.3%) and 22:5n-3 (3.1 vs. 3.3%), whereas the total AC of n-3 FA was not affected by previous feeding program (8.7 vs. 13.6%; $P > 0.10$). These results suggest that the rate of AC of n-3 FA and HUFA content is independent of BW which provides flexibility as to when n-3 FA might be fed to produce n-3 enriched pork.

Key Words: apparent conversion, n-3 fatty acid, pigs

149 Effect of dietary conjugated linoleic acid on markers of intramuscular adipocytes in pork. K. M. Barnes*[1], N. Winslow[1], A. Shelton[1], and M. J. Azain[2], [1]*West Virginia University*, *Morgantown,* [2]*University of Georgia*, *Athens*.

Dietary conjugated linoleic acid (CLA) has been reported to decrease backfat and increase marbling in hogs. Our objective was to determine if the increased marbling was related to increased intramuscular adipocyte development. Barrows (n = 20, 53 kg) were penned in pairs and pens were randomly allotted to receive finishing diets containing 1% soybean oil (SBO) or 1% CLA oil (60% mixed CLA isomers) for 6 wks. Body weight and feed intake were determined weekly. At slaughter loin samples were obtained and flash frozen for RNA extraction and real time RT-PCR analysis of gene expression. Following a 24 h chill, carcasses

were ribbed and loin eye area (LEA) and backfat depth were measured, and subjective marbling and color scores were assigned. Loin, backfat, and belly fat samples were obtained for fatty acid analysis by gas chromatography. Dietary CLA did not affect body weight or feed intake at any point, nor did treatment groups differ in hot carcass weight, LEA, or color. CLA-fed pigs did have less ($P < 0.05$) backfat than SBO-fed pigs (25 vs. 30 mm, respectively) and had a non-significant ($P = 0.164$) increase in marbling score (3.1 vs. 2.4, respectively). The cis9,trans11 and trans10,cis12 CLA isomers were incorporated ($P < 0.001$) into backfat and belly fat but only trans10,cis12 CLA was increased ($P < 0.001$) in the loin of CLA-fed pigs. In all 3 tissues, the proportion of saturated fatty acids were increased ($P < 0.001$) by CLA. Relative gene expression for markers of preadipocytes (Pref-1), differentiating adipocytes (PPARγ), and mature adipocytes (Ap2 and Perilipin) were determined and normalized to the expression of acidic ribosomal phosphoprotein. No significant differences were detected but the expression of PPARγ (1.49 vs. 1.21, $P = 0.374$), Perilipin (1.81 vs. 1.44, $P = 0.485$), and Ap2 (1.75 vs. 1.21, $P = 0.205$) all were numerically greater in CLA-fed pigs than SBO-fed pigs. These preliminary results indicate that the increase in marbling in pigs fed CLA may be related to increased intramuscular adipocytes.

Key Words: conjugated linoleic acid, marbling, pork

150 Effects of dietary polyunsaturation level and genistein supplementation on performance and meat quality in quails reared under heat stress. N. Sahin* and C. Orhan, *Firat University Faculty of Veterinary Medicine Department of Animal Nutrition*, *Elazig, Turkey*.

This experiment was conducted to investigate the effects of dietary polyunsaturated fatty acids (PUFA) level (15 *vs*. 45%) and genistein supplementation (GS, 0, 400, and 800 mg/kg) on performance and muscle lipid profile in quails (*Coturnix coturnix japonica*, n = 360) reared under thermoneutral (TN, 22°C) and heat stress (HS, 34°C) conditions. Data were analyzed by 3-way ANOVA using the MIXED Procedure. Each treatment was replicated in 10 cages, each containing 3 birds, from d 10 to 42. HS condition decreased body weigh gain (BWG, 137 *vs*. 150 g) and cumulative feed intake (CFI, 657 *vs*. 708 g) and increased feed conversion ratio (FCR, 4.82 *vs*. 4.72) compared with TN condition ($P < 0.0001$ for all). Increasing dietary PUFA level was associated with decreases in BWG (5.26%; $P < 0.0001$) and CFI (6 g; $P < 0.01$) and an increase in FCR (4.61%; $P < 0.0001$). There were linear increases in BWG from 142 to 145 g and FCR from 4.83 to 4.73, with increasing GS ($P < 0.05$). Quails reared under TN condition had greater proportions (g/100 g fat) of PUFA (25 vs. 21), monounsaturated fatty acid (MUFA, 45 vs. 43), ω-6 (13 vs. 11), and ω-3 (12 vs. 10.38) and a less proportion of saturated fatty acid (SFA, 30 vs. 36) than quails reared under HS condition ($P < 0.0001$ for all). Quails fed diet containing 15% PUFA had greater MUFA (52 vs. 35) and SFA (36 vs. 31) and less PUFA (12 vs. 34), ω-6 (10 vs. 14), and ω-3 (2 vs. 20) than quails fed diet containing 45% PUFA ($P < 0.0001$ for all). Muscle FA profile did not vary by GS. Quails that were reared under HS condition (0.48 vs. 0.29 µg/g) and quails that were fed diet containing 45% PUFA (0.91 vs. 0.78 µg/g) had greater muscle malondialdehyde (MDA) content than their counterparts ($P < 0.0001$ for both). GS did not affect muscle MDA content. There were variable 2-way treatment interaction effects on response variables. In conclusion, increasing dietary PUFA level and GS may improve performance and meat quality in heat stress.

Key Words: PUFA, genistein, quail

151 Evaluating the efficacy of OptiCal under varying levels of dietary fat inclusion. J. D. Hamburg*[1], A. B. Batal[1], and S. D. Frankenbach[2], [1]*University of Georgia*, *Athens,* [2]*JBS United Inc.*, *Indianapolis, IN*.

Fat inclusion in diets has been shown to decrease gut transit which increases the energy availability of the diet. Thus, the objective of these studies was to determine the efficacy of OptiCal in diets with various levels of fat inclusion. Two 4 × 2 factorial studies were conducted in which a standard corn-soybean meal-distillers dried grains plus soluble diet was fed to broilers for performance and AME determination and also to roosters for TME_N determination. There were 4 levels of fat: 0, 1, 2, and 3% and 2 levels of Optical, 0 and 0.25lbs/ton. The diets were formulated to meet digestible amino acid requirements; however the ME of the diets varied with fat inclusion. The calculated ME of the control diet (0% fat and no Optical) was 2,900 kcal/kg and the ME increased 84 kcal/kg for every 1% inclusion of fat. To determine TME_N, a traditional precision-fed rooster assay in which 8 birds per diet were fasted for 24 h then crop intubated with 35 g of the test diets. Excreta were then collected for 48 h. For the chick assay 288 male broiler chicks were placed in Petersime battery brooders and fed a standard corn-soybean meal crumble diet. At 4 d of age, 9 replications of 4 chicks were weighed and assigned to one of the 8 dietary treatments. Body weight and feed intake were measured at 9 and 18 d of age. Excreta were collected at d 18 for AME determination. The TME_N values of the diets increased as the fat inclusion in the diets increased from 0 to 3% fat (3,036 to 3,234 kcal/kg, respectively). The efficacy of Optical on releasing energy, increasing the TME_N value improved as the inclusion of fat increased, on average the TME_N value of the diets with Optical were 57 kcal/kg higher than the diets without Optical. There was no effect of the addition of Optical on the diet without any fat inclusion. The inclusion of fat improved the feed:gain ratio as compared with the diets without fat (1.50 to 1.73, respectively). There was a interaction between fat inclusion and enzymes on the feed:gain ratios at 18 d of age. Based on the results of these studies fat inclusion levels in the diet appears to have an effect on enzyme efficacy.

Key Words: fat, enzymes, OptiCal

152 Fat digestibility in enzymatically treated soybean meal without and with choice white grease and vegetable oil. K. P. Goebel* and H. H. Stein, *University of Illinois*, *Urbana*.

An experiment was conducted to measure the digestibility of fat by weanling pigs fed enzymatically treated soybean meal and either soybean oil or choice white grease. Two sources of enzymatically treated soybean meals were used (HP-300 and HP-350). These meals are similar with the exception that an emulsifier, lecithin, is included in HP-350, but not in HP-300. The HP-300 meal contained 57.07% CP, 1.44% acid-hydrolyzed ether extract (AEE), and 2.30 trypsin inhibitor units (TIU) per mg, and HP-350 contained 53.60% CP, 3.73% AEE, and 1.50 TIU per mg. Two diets were formulated by mixing cornstarch, sugar, and each source of soybean meal. Two additional diets that were similar to the initial 2 diets with the exception that 6% choice white grease or 6% soybean oil was added to these diets were also formulated. Thirty-two weanling barrows (initial BW: 13.3 ± 0.8 kg) were randomly allotted to the 4 diets with 8 replicate pigs per diet in a 2 × 2 factorial design. Pigs were housed in metabolism cages. Pigs were fed experimental diets for 14 d with total collections of feces during the final 5 d. Feed intake and DM output were not different among treatments. The apparent total tract digestibility (ATTD) of DM and GE were not different among treatments regardless of soybean meal and fat source. The ATTD of AEE in HP-300 and HP-350 mixed with soybean oil was not differ-

ent (80.4 and 75.7%, respectively). The ATTD of AEE in HP-300 and HP-350 mixed with choice white grease was also not different (80.2% and 79.3%, respectively). Results indicated that the added lecithin in HP-350 did not increase fat digestibility in pigs fed diets supplemented with soybean oil or choice white grease.

Key Words: fat digestibility, lecithin, soybean meal

153 Effect of dietary DHA levels and different sources of oil (fat) on egg yolk DHA and ω-3 fatty acids levels. M. K. Manangi*, B. Wuelling, J. Hux, S. Carter, C. D. Knight, and M. Vazquez-Anon, *Novus International, Inc.*, *St. Charles, MO*.

A 5 wk experiment was conducted to evaluate the effect of different levels of DHA (docosahexaenoic acid) as DHA GOLD (a dried whole cell algae product, derived from *Schizochytrium* sp., contains a minimum of 18% DHA by weight) and sources of oil (fat) on egg yolk DHA and ω-3 fatty acids deposition. A total of 216 Hy-Line W-36 commercial laying hens, 40 wk old, were randomly assigned to 6 treatments with 36 cages/treatment and one hen/cage. The trial design was a 2 × 3 factorial with 2 levels (0 and 1%) of DHA GOLD and 3 sources (canola, flax and corn oil) of oil. Results indicate that DHA GOLD and oil sources had significant ($P < 0.05$) interaction on DHA, and total ω-3s fatty acids in eggs. Supplementation of DHA GOLD to diets with canola, flax and corn oil increased ($P < 0.05$) the DHA deposition from 19 to 163, 33 to 158 and 19 to 170 mg/egg, respectively. Supplementation of DHA GOLD to diets with canola oil and corn oil increased total ω-3s from 125 to 338 and 111 to 376 mg/egg, respectively. The DHA GOLD and flax oil combination did not affect ($P > 0.05$) total ω-3s. In summary, under present experimental conditions dietary supplementation of DHA GOLD increased egg DHA content that meets toward recommended daily allowance irrespective of tested oil sources. Total ω-3s in eggs increased in response to supplemental DHA GOLD for canola and corn oil diets but not for flax oil.

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Key Words: layer, DHA, ω-3s

154 Effect of different levels of flaxseed and DHA GOLD on egg yolk DHA deposition. M. K. Manangi*, B. Wuelling, J. Hux, S. Carter, C. D. Knight, and M. Vazquez-Anon, *Novus International, Inc.*, *St. Charles, MO*.

A 5 wk experiment was conducted to evaluate the effect of different levels of flaxseed, and DHA (docosahexaenoic acid) as DHA GOLD (a dried whole cell algae product, derived from *Schizochytrium* sp., contains a minimum of 18% DHA by weight) on egg yolk DHA. A total of 216 Hy-Line W-36 commercial laying hens, 24 wk old, were randomly assigned to 9 treatments with 24 individual cages per treatment and one hen per cage. The trial design was a 3 × 3 factorial with 3 levels (0, 0.5 and 1%) of DHA GOLD and 3 levels (0, 3 and 6%) of flaxseed. All diets were isolipidic and soybean oil was used to replace oil from flaxseed. Results indicated a significant ($P < 0.05$) interaction of DHA GOLD and flaxseed levels on DHA, total ω-3 fatty acids, and vitamin E levels. DHA and ω-3s content in egg increased linearly with the addition of DHA GOLD by itself or in the presence of flaxseed. Addition of 3% flaxseed improved DHA egg content from control but was less effective than DHA GOLD treatments. Further increase of flaxseed from 3 to 6% did not result in additional DHA deposition in egg, except when 0.5% DHA GOLD was present in the diet. The optimum DHA level of 173mg/egg was achieved by feeding hens' 1% DHAGOLD + 3% flaxseed compared with 35.9mg DHA/egg for hens fed the control diet ($P < 0.05$). The combination of 1% DHA GOLD and 3% flaxseed also resulted in significantly ($P < 0.05$) higher total ω-3s (389mg/egg) compared with hens fed diets supplemented with 0 or 0.5% DHA GOLD in combination with 0, 3 or 6% flaxseed. Supplementation of 1% DHA GOLD alone with no flaxseed resulted in a deposition of 141mg of DHA/egg whereas 6% flaxseed with no DHA GOLD resulted in 52mg of DHA/egg. Eggs from hens fed 1% DHA GOLD showed an increase of 373% vitamin E compared with eggs from non-DHA GOLD supplemented hens. In summary, DHA GOLD supplementation was more effective at enriching eggs with DHA than flaxseed by itself. Combination of 3% flaxseed with 1% DHA GOLD optimized the deposition of DHA in egg.

DHA GOLD is a registered trademark of Martek Biosciences Corporation, USA

Key Words: layer, DHA, ω-3s

155 The interaction of dietary fatty acids on the egg yolk fatty acid composition. R. Poureslami*[1,4], K. Raes[2], and E. Delezie[3], G. Huyghebaert[3], A. B. Batal[1], and S. De Smet[4], [1]*University of Georgia*, *Athens,* [2]*University College West-Flanders*, *Kortrijk, Belgium*, [3]*Institute for Agricultural and Fisheries Research*, *Melle, Belgium*, [4]*Ghent University*, *Melle, Belgium*.

Two experiments were conducted to investigate the interaction of dietary fatty acids (FA) on the egg yolk FA composition. In Exp I, 288 ISA-brown laying hens (45–50 wk of age) were divided into 32 dietary treatments in 3 replicates. Diets were prepared mixing a type of fish oil (FO) with 4 vegetable oils in different proportions resulting in a wide range of diet FA composition. Two levels of fat were introduced to the diets (3 and 6%). In Exp II, 63 hens were assigned to each of 7 dietary groups. A mixture of 2 levels and 3 types (differing in 20:5n-3/22:6n-3 ratio) of FO in combination with 2 vegetable oils were applied. Stepwise multiple regression and ANOVA were used to analyze the data in Exp I and II respectively. In Exp I, dietary saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA) FA and the interaction between them affected SFA and MUFA proportions in the egg. The egg 18:2n-6 proportion was mainly explained by the dietary provision of 18:2n-6 (Partial R^2 55%) followed by the inverse impact of dietary MUFA. The 20:4n-6 composition in the egg was inversely related to the dietary n-3 long chain (LC) PUFA (Partial R^2 50%), more than to the dietary level of the precursor 18:2n-6. The linear effect of dietary 18:3n-3 was very determinant for the egg 18:3n-3 proportion (Partial R^2 93%) while, it had a negligible impact on the n-3 LC PUFA composition in the egg (Partial R^2 7%). About 77% of the variation in the egg yolk 22:6n-3 composition was explained by 22:6n-3 proportion in the diet. In Exp II, the level of FO (2 v. 1%) was more effective than its type on the n-3 LC PUFA composition in the egg. In conclusion, interactions between dietary FA affect SFA and MUFA composition in the egg while, direct dietary provision is the most crucial factor in achieving high deposition of n-3 FA in the egg yolk.

Key Words: fatty acids, interaction effect, egg yolk

156 The effect of omega-3 fatty acid rich algae biomass supplementation on production and egg and plasma components from 61 to 69 weeks of age. H. M. Yakout*[1], C. L. Novak[2], and Z. Wen[3], [1]*Alexandria University*, *Alexandria, Egypt*, [2]*Land O'Lakes Purina Feed*, *Kansas City, MO,* [3]*Virginia Tech*, *Blacksburg*.

Commercial White Lohmann LSL-Classic hens (n: 192) were randomly assigned to one of 4 dietary treatment groups to test the use and response of omega-3 fatty acid containing algal biomass supplementation on egg production parameters and egg components. Biomass was supplemented to a corn-soybean meal based diet at a rate of 0, 2, 4 or 8% establishing treatments 1, 2, 3 and 4, respectively. All diets were iso-caloric and iso-nitrogenous and were fed ad libitum from 61 to 69 wks of age. Cage was considered the experimental unit (4 hens/ cage) with each treatment replicated 12 times. Overall, Trt had no affect on feed consumption which averaged 117.6 g/ h/ d. Egg production ranged from 89.8 to 91.7% for all treatments ($P \geq 0.05$) with the highest producing hens consuming diet 1 and lowest consuming diet 4. Additionally, no significant differences were observed among trt for feed efficiency which averaged 0.517 g. egg mass /g. feed. Trt 1 had numerically higher egg weights (68.1 g.) compared with biomass supplemented trt with an average of 66.53 g/ egg. Trt 1 had numerically the greatest egg mass (62.4 g.) and dietary treatments had no significant effects on wet egg components. Trt 2 had numerically the best specific gravity value (1.087). Overall, increasing dietary biomass resulted in elevated yolk color ($P \leq 0.001$) with the darkest noted in eggs from hens consuming trt 4 (7.2; using a Roche Color fan), while trt 1 was the lightest (6.5). Yolk and plasma total lipids, and yolk phospholipids were similar among treatments, while plasma phospholipids were reduced ($P \leq 0.06$) in hens consuming trt 3 (524.7 mg/dL) as compared with hens fed trt 1 (736.0 mg/dL). Yolk DHA content was significantly increased with all dietary biomass levels up to 8% (2.64%) as compared with the control (0.31%). Based on the information from this trial, supplementing a corn-soybean meal based diet with biomass up to 8% during late first cycle lay resulted in minimal affects on production parameters. Additionally, yolk color and DHA content was increased while plasma phospholipids were reduced by feeding 4 or 8% biomass.

Key Words: biomass, plasma phospholipids, laying hens