

Metabolizable energy of MBM depends on raw material source and processing condition, is variable. In Iran, MBM are produced from slaughter wastes of beef, lamb, goat and or camel. The product is used mostly in poultry diets but there are not any data of its true metabolizable energy (TMEn) content. The objective of present study was to determine TMEn in MBM samples from Iran. Six composed samples were taken randomly from a large rendering plant in east of Iran and kept at -20 C until chemical analysis. Gross energy (GE) by Parr adiabatic calorimeter bomb and DM and CP (6.25 \*N) were determined according to AOAC (1990) methods. True metabolizable energy (TME) in the samples was determined by Sibblald's precision fed assay, using thirty five intact leghorn roosters (1989). Endogenous

energy loss (EEL) was measured in one group of five roosters which fasted 48 hours. The obtained data were subjected to one way analysis by GLM procedures of SAS (2002). Comparison of means was done by Duncan test. Mean EEL and EEL corrected to zero nitrogen balance were 14.6 and 7 kcal/48 h. True dry matter digestibility, gross energy efficient (TMEn/GE), TME and TMEn values were significantly different among sample (0.05). Mean (and range) of TME and TMEn were 3183(2692 to 3884) and 2993(2473 to 3253) kcal/kg respectively. The results showed that available energy content of MBM from Iran's animal rendering plants is high, but like the results of other reports, TMEn values is relatively variable.

**Key Words:** TMEn, meat and bone meal

## Metabolism and Nutrition: Nutrition B - Enzymes & Manufacturing

**225 Variability in feed value of Australian wheat-, triticale- and sorghum-based diets supplemented with and without enzymes for broilers.** T. A. Scott\*, *University of Sydney, Camden, NSW, Australia.*

Our definition of feed value now includes measurements of variation in nutrient intake that have been directly correlated with growth. Within cereal grains, variation in intake can be in excess of 20% and is not related to energy or protein levels of the diets. In the present study, 45 grains (34 wheat, 8 triticale and 3 sorghum) were ground and included (750 g/kg) in mash diets (wheat and triticale diets had a different basal diet from sorghum-based diets); all diets contained 1% acid insoluble ash marker. The diets were then split and one portion supplemented with 0.5 g/kg xylanase and phytase (Danisco Animal Nutrition, UK). The 90 diets (45 cereal-based diets with or without enzyme) were each full fed to one cage of six male broilers (Cobb 500) in four consecutive bioassays from 4 to 17 d of age. At 16 d a 6 h excreta collection was frozen, freeze-dried, ground and analysed to determine the AME (kcal/kg diet). Feed intake, growth and mortality were recorded from 4 to 17 d and used to calculate feed conversion ratios. Fifteen of the 34 wheat samples had been previously tested in another bioassay; diets contained no enzyme(s) and birds were five-weeks of age; AME was determined by total collection. The present study supports earlier work that demonstrated measurements of feed value must not ignore the variation in intake, growth and efficiency. Variation in feed intake of wheat-based diets (~20%) was positively correlated ( $r > 0.70$ ) with body weight; while correlations between intake and AME were positive ( $r = 0.30$ ). Variation in performance of triticale samples was similar to wheat, while no enzyme response was observed for sorghum-based diets due to low levels of soluble non starch polysaccharides. The 15 wheat samples measured in two different bioassays had significant positive correlations for measures of performance, but no relationship for measures of AME. This indicates that factors within these common grains consistently influenced performance in a similar manner, but not AME. Further work is required to understand the cause of variation or limitation in intake and how this can be minimized.

**Key Words:** AME, cereals, feed intake

**226 Should oligosaccharides be considered as antinutritive factors and target substrates for enzyme use in broiler chicken diets?** B. A. Slominski\*<sup>1</sup>, X. Meng<sup>1</sup>, L. D. Campbell<sup>1</sup>, W. Guenter<sup>1</sup>, and O. Jones<sup>2</sup>, <sup>1</sup>*University of Manitoba, Winnipeg, MB, Canada,* <sup>2</sup>*Canadian Bio-Systems Inc., Calgary, AB, Canada.*

Removal of oligosaccharides has been indicated to be beneficial for poultry as an increase by 20% in the TME of SBM was noted following ethanol extraction. Interpretation of the data, however, is confounded by the fact that ethanol extraction would result in the removal of many other components of the meal. Specific removal of oligosaccharides by using  $\alpha$ -galactosidase enzyme has been investigated in our laboratory. In many studies, very low digestibility of oligosaccharides in enzyme supplemented diets was observed. Factors capable of causing enzyme inactivation were evaluated and the low pH in the upper gut was considered to be the most significant. Recently, a new preparation of  $\alpha$ -galactosidase has been evaluated for its ability to improve the rate of oligosaccharide hydrolysis. Incubation of 5g of SBM with enzyme for 90 min at 40°C resulted in a significant reduction in oligosaccharide content (from 68.8 to 42.4 mg/g) at an enzyme to substrate ratio of 1:175 and almost complete oligosaccharide hydrolysis (from 68.8 to 4.5 mg/g) at an enzyme to substrate ratio of 1:35. In studies with broiler chickens (5-18 d) using wheat/SBM/canola meal diets, the total tract digestibility of oligosaccharides averaged 27.2% for a control diet, and 32.1 and 57.4%, respectively, for 0.01% (1:175 enzyme to substrate ratio) and 0.05% (1:35 enzyme to substrate ratio)  $\alpha$ -galactosidase supplemented diets. Despite the fact that the hydrolysis of oligosaccharides was substantial at the 0.05% enzyme level, it was not reflected in any improvement in growth performance with weight gain and feed conversion values of 439.7 g/14 days and 1.53 being identical to those of 447.4 and 1.52 for the control diet, respectively. It would appear evident that the oligosaccharides raffinose and stachyose do not pose a nutritional concern and that the use of  $\alpha$ -galactosidase enzyme to enhance their digestibility may not be beneficial.

**Key Words:** oligosaccharides,  $\alpha$ -galactosidase, broilers

**227 Enzyme for corn-soybean meal diet: Target substrates and enzyme efficacy in broiler chickens.** B. A. Slominski\*<sup>1</sup>, X. Meng<sup>1</sup>, D. Boros<sup>1</sup>, L. D. Campbell<sup>1</sup>, W. Guenter<sup>1</sup>, W. Jia<sup>1</sup>, and O. Jones<sup>2</sup>, <sup>1</sup>University of Manitoba, Winnipeg, Canada, <sup>2</sup>Canadian Bio-Systems Inc., Calgary, Canada.

In enzyme development studies factors investigated included: a potential deficiency in key digestive enzymes in young chickens, antinutritive properties of oligosaccharides and poor utilization of fiber components. No positive effects of dietary amylase and protease additions in broilers fed a corn/SBM diet were noted. Weight gain (WG) and feed efficiency (FE) averaged 91.6, 95.5, 97.1g and 1.41, 1.38, 1.38 for the control and the amylase or amylase plus protease supplemented diets, respectively, in week one, and 235.9, 242.8, 240.0g and 1.43, 1.40, and 1.41 in week two of the experiment. This data was corroborated by similar ileal starch (96.8, 96.8, 96.9%) and protein (83.9, 80.1, 79.6%) digestibility values indicating that a digestive enzyme deficiency in young chickens may not be as pronounced as originally thought. Specific removal of oligosaccharides by using  $\alpha$ -galactosidase enzyme was investigated and, although a significant oligosaccharide hydrolysis in the chicken gut was achieved, no improvement in growth performance was noted. A study was also carried out to target the NSP of SBM. Significant NSP depolymerization was achieved in vitro using a multicarbohydase enzyme and a series of experiments were conducted to determine its efficacy in broilers fed corn-SBM diets. On average, WG and FE improved by 3.9% (450 vs 468 g/14 days) and by 3.2% (1.44 vs 1.39), respectively. However, the effect of enzyme addition was only significant ( $P < 0.05$ ) for WG in two trials and for FE in four trials. As determined in three trials, there was an effect of enzyme addition on total tract DM (71.5 vs 73.3%) and NSP (5.7 vs 15.2%) digestibilities, phytate P utilization (21.1 vs 39.2%) and AMEn content (2963 vs 3047 kcal/kg diet). Ileal protein digestibility increased from 79.6 to 84.0%. It can be concluded that the use of a multicarbohydase component would improve the overall efficacy of dietary enzymes in corn-SBM diets.

**Key Words:** corn-SBM diet, enzyme, broilers

**228 Improving soybean meal digestion during the full first cycle of lay.** A. E. Sefton\*<sup>1</sup> and S. Leeson<sup>2</sup>, <sup>1</sup>Alltech, Inc., Guelph, ON, Canada, <sup>2</sup>University of Guelph, Guelph, ON, Canada.

Vegpro® (Alltech, Inc., Nicholasville, KY) is an enzyme combination specifically designed to enhance the digestibility of plant based protein supplements, and has been found to improve the digestibility of plant protein supplements by 7% for energy, protein and amino acids. This long-term layer trial was undertaken to test the efficacy of Vegpro when fed to layers, from 19 to 72 weeks of age. Four treatment groups with 80 individually housed, 19 week old Shaver Whites were used. The test rations were formulated to the same nutrient specifications as the control (C) treatment except that the ingredient profile of the soybean meal was raised by 7% (L), 10.5% (M) and 14% (H) for metabolizable energy, crude protein, and amino acids. The rations followed the Shaver White recommendations. The lay period was divided into 13, 28 day periods. There were no differences among treatments until the 8th period when feed consumption of treatment H was less than treatment L ( $P < 0.05$ ), there were no other differences in feed intake. This difference mirrored the lower hen egg production of treatment H in the 9th period when it was lower ( $P < 0.05$ ) than treatment C and M and lower than ( $P < 0.05$ ) treatments C, L and M in periods 10 and 11. There were no other differences in egg production,

mortality, feed intake, egg weight, shell deformation or albumen height. These results support the ability of Vegpro to improve digestibility of soybean energy, protein and amino acids by at least 7% in layers.

**Key Words:** layer, Vegpro, enzymes

**229 The effect of enzymes on degradation of corn DDGS using in vitro assay.** S. Dalsgaard\*<sup>1</sup> and M. Hruby<sup>2</sup>, <sup>1</sup>Danisco Innovations, Brabrand, Denmark, <sup>2</sup>Danisco Animal Nutrition, St. Louis, Missouri.

Corn Distiller Dried Grains with Solubles (DDGS) availability as a feed ingredient has been increasing with an unprecedented growth in ethanol or ethyl alcohol production. Traditionally, by-products of ethanol production have been used mainly in ruminant diets but most of the plants today are capable of producing DDGS, which can be used also at higher inclusions in monogastric animal feeds. The available scientific literature suggests that DDGS inclusion between 5-20% in pig and poultry diets can be achievable without a negative effect on performance. DDGS contain concentrated levels of remaining compounds found in corn after removal of most of the starch. It has been shown to be rich in protein, fat, phosphorus, and fibres. In the past, exogenous or feed enzymes have shown to improve nutritive value and reduce variability of many feed ingredients. DDGS could potentially be another ingredient benefiting from a targeted exogenous enzyme action.

Fourteen DDGS samples were collected in the US and in vitro screening was conducted in order to determine; 1) the level of nutrients in DDGS, 2) the type and level of potential substrates for enzyme action, and 3) the enzyme(s) match for the substrate. The results suggested that digestibility of two compounds, pentosans and phytate P, could potentially be improved with an addition of exogenous enzyme. Different enzymes (two types of endo-xylanases and one 6-phytase) have been tested for their capability to degrade pentosans and phytate, respectively. The in vitro method consisted of a two-step procedure and its goal was to mimic the broiler's gastrointestinal tract; 1) 45-min pepsin (pH 4.3) and 2) 60-min pancreatic incubation (pH 7-7.3), both at 40°C (104°F), followed by a determination of soluble xylan and phosphate. The results showed an effect of xylanase addition on fibre hydrolysis. Phytase and phytase/xylanase combination improved the level of soluble phosphate significantly. The evaluation showed that specific feed enzymes could contribute to DDGS' nutritive value improvement. However, the enzyme application will need to be targeted to account for the nutrient and antinutrient variability in different DDGS sources.

**Key Words:** DDGS, pentosans, xylanase

**230 Effect of formulating of B-Mannanase (Hemicell Feed Enzyme) into turkey tom diets varying in amino acid density.** M. E. Jackson\*<sup>1</sup>, J. Mitchell<sup>2</sup>, and G. F. Mathis<sup>3</sup>, <sup>1</sup>ChemGen Corp, Gaithersburg, Maryland, <sup>2</sup>Akey Inc, Lewisburg, Ohio, <sup>3</sup>Southern Poultry Research, Athens, Georgia.

B-mannan, a polysaccharide found in soybean meal and other plant proteins, exhibits powerful anti-nutritive effects in monogastrics. The enzyme B-mannanase (Hemicell) has been shown to improve performance and live weight uniformity in turkeys. It has been estimated that this enzyme results in an uplift of approximately 120 Kcal/kg ME. Turkey producers may elect to assign Hemicell a lesser

energy benefit with the aim of reducing feed costs and improving performance. An experiment was conducted to test Hemicell at 2 AA planes in commercial corn-soybean based diets. Four dietary treatments consisted of two AA planes (commercial and high after 9 weeks of age (increased lysine and methionine levels by approximately 0.07 and 0.05%, respectively)) with and without Hemicell formulated in at a reduced matrix of 55 Kcal/Kg uplift. Treatments were assigned to 8 replicate pens with 11 Hybrid male turkeys per pen. Body weight was determined at 0, 6, 9, 12, 15, and 20 weeks of age and feed consumption was determined between these ages. Individual weights were determined at 9 and 20 weeks of age. Hemicell formulated into diets resulted in improvements in weight gain and feed conversion in both amino acid planes at all ages tested. There were no significant effects of increasing the AA density. At 20 weeks of age, formulating in Hemicell improved weight gain by 3.7% and FC by 5.5 points (both  $P < 0.05$ ) at the commercial AA plane. At the high AA plane, effects were positive but not significant. Body weight % CV was significantly improved when Hemicell was formulated into diets at 9 and 20 weeks of age ( $P < 0.05$ ) but was unaffected by AA density. The experiment revealed that when formulated in turkey diets with an ME uplift of 55 Kcal/kg, Hemicell improves turkey performance and live weight uniformity.

**Key Words:** hemicell, turkeys, metabolizable energy

**231 Effect of  $\beta$ -mannanase (Hemicell® feed enzyme) on acute phase protein levels in chickens and turkeys.** D. M. Anderson and H.-Y. Hsiao\*, *ChemGen Corp., Gaithersburg, Maryland.*

Acute phase proteins (APP) are an aspect of the innate immune system and some APP accumulate in blood to high levels in response to various forms of stress. The APP called  $\alpha$ -1-acid glycoprotein (AGP) is known to be very responsive in birds and is readily measured by a radial immunodiffusion assays. The level of AGP in broilers was monitored in a series of cage and pen trials, and in turkeys from a pen trial. All experiments used commercial type corn/soybean diets. The AGP level was significantly elevated in broilers after infection with three *Eimeria* species, and also by the exclusion of the antibiotic (BMD) from the diet. In trials with broilers at 21 and 42 days, as well as turkeys at market weight, the addition of  $\beta$ -mannanase to the corn/soybean diets significantly reduced the blood AGP level while also providing significantly increased growth performance as shown by a decrease in weight adjusted feed conversion. The innate immune system is activated by molecular patterns commonly found in pathogens, and high molecular weight mannan is one of the patterns that induce a strong response. A possible mechanism for the observed  $\beta$ -mannanase mediated reduction of AGP will be discussed. Measuring APP provides a convenient tool to monitor stress in birds and the levels measured were predictive for the growth performance in these studies.

**Key Words:** Hemicell®  $\beta$ -mannanase,  $\alpha$ -1-acid glycoprotein (AGP), innate immune system

**232 Influence of source and particle size of fibrous ingredients on nutrient utilization of broilers at nine days of age.** J. M. González-Alvarado<sup>1</sup>, E. Jiménez-Moreno<sup>2</sup>, D. González-Sánchez<sup>2</sup>, R. Lázaro<sup>2</sup>, and G. G. Mateos\*<sup>2</sup>, <sup>1</sup>Universidad Autónoma de Tlaxcala, Mexico, <sup>2</sup>Universidad Politécnica de Madrid, Spain.

The influence of including additional fiber into low-fiber diets on total tract apparent retention of nutrients (TTAR) was evaluated in

nine-d-old chicks. There were six dietary treatments and five replicates (a cage with 14 chicks) per treatment. The control diet (diet A) was based on rice, soy protein concentrate, fish meal, yellow grease, and 3% sepiolite and contained 3,100 kcal ME/kg, 1.31% total lysine, and 1.5% crude fiber. Diets B, C, and D were similar to diet A but sepiolite was substituted (wt/wt) by oat hulls (OH), sugar beet pulp (SBP), or microcrystalline cellulose (CEL). Diets E and F were identical to diets B and C but the fiber sources were ground to pass through a 0.5-mm screen instead of a 2.0-mm screen. All diets contained 2% celite as a source of acid-insoluble ash and were fed as mash. At 9 d of age fecal samples were collected and fecal digestibility of soluble ash (SA), DM, organic matter (OM), ether extract (EE), and N retention, and AMEn of the diets were determined. Treatment means were analyzed by adequate non-orthogonal contrasts to study the effects of fiber inclusion and fiber particle size. Fiber inclusion increased AMEn of the diet (3,098 vs. 3,135 kcal/kg;  $P < 0.05$ ) and TTAR of most nutrients (DM, SA, and EE;  $P < 0.001$ ). Oat hulls and SBP were most effective in improving nutrient utilization than CEL ( $P < 0.01$ ). Also, OH inclusion was more effective than SBP inclusion in improving AMEn (3,196 vs. 3,129 kcal/kg) and nutrient digestibility ( $P < 0.001$ ). In general, a reduction of particle size of the fiber source improved digestibility of most nutrients except for EE. We conclude that the inclusion of additional fiber improves nutrient utilization in young chicks fed low-fiber diets (1.5% CF) and that OH inclusion is more beneficial in this respect than SBP or CEL inclusion.

**Key Words:** particle size, fiber inclusion, digestibility

**233 The effects of sucrose or electrolyte supplements and corn particle grind size on Ross broilers during stress and during post-stress recovery.** W. S. Virden\*, A. C. DeLeon, A. Corzo, and M. T. Kidd, *Mississippi State University, Mississippi State.*

The detrimental effects of physiological stress on broilers are well known. However, little research exists to delineate the effects of different nutritional regimes on the stress response in broilers. Hence, an experiment was conducted to examine the effects of sucrose and electrolyte water supplements on broilers during stress, as well as particle grind size during post-stress recovery. Ross x 308 male broilers (420) were placed in 35 floor pens, and given common starter diets from d 1 to 20. From d 21 to 24, chicks were given *ad libitum* access to one of four dietary treatments: 1) control (7 replicate pens); 2) control diet containing 5 mg of CS/kg diet (14 replicate pens); 3) as 2 + a sugar-water solution (0.15 g of sucrose/ml) (7 replicate pens); 4) as 2 + electrolyte-water solution (0.45 g of K, 0.04 g of Na, and 0.0005 g Mg/ml) (7 replicate pens). On d 25, broilers were given *ad libitum* access to a pelleted control diet, except 7 replicate pens that received CS, which were given the control diet with 30 % of corn replaced as roller mill corn post pelleting. Performance parameters were measured on d 25 and d 46, and carcass parameters were measured on d 47. During the stress period, BW gain was higher ( $P < 0.05$ ) for broilers receiving the control diet than broilers receiving treatments 2 or 3. However, BW gain did not differ between treatments 1 and 4. Feed intake was higher ( $P < 0.05$ ) in broilers given treatments 2 and 4 than those fed control. However, broilers given treatment 3 had lower ( $P < 0.01$ ) feed intake than those given all other treatments. Broilers fed treatment 1 had lower ( $P < 0.01$ ) feed conversion than broilers given treatments 2 and 4, but not 3. Water intake was lower ( $P < 0.05$ ) for broilers receiving control than for all treatments given CS. From d 26 to 46, BW gain and feed intake did not differ between treatments. However, post-stress feed conversion was lower ( $P < 0.05$ ) for broilers

fed electrolytes or sugar-water solution during stress, than the control. Adding roller mill corn to the recovery diet did not affect performance. Carcass parameters did not differ among treatments.

**Key Words:** broiler, stress, electrolyte

**234 Efficacy of germination time and use of a preservative (potassium di-formate) on feeding value of wheat for broilers.** C. M. Tomkinson and T. A. Scott\*, *University of Sydney, Camdne, NSW, Australia.*

Germination of seeds changes the physiochemical profile of seeds and may improve nutrient availability, reduce ANFs as well as improve the health of broiler chickens. The same conditions also provide ideal opportunities for microorganism growth and potential contamination of diets. This trial evaluated the effect of germination time (0, 21 or 42 h of controlled (moisture, darkness, 20 C temperatures; followed by 48 h drying (40 C). To minimise microbial contamination, the extended (42 h) germination treatment was treated with or without potassium di-formate (3 g/kg grain; BASF, Australia). The diets (grain inclusion was 750g/kg) were formulated to meet or exceed the nutritional requirements of Cobb (500) male broiler chicks from 0 to 21 d of age; diets contained 1% acid insoluble ash marker. Diets were split and one portion supplemented with xylanase and phytase (0.5 g/kg diet; Dansico Animal Nutrition, UK). The 8 diets were full fed to 6 cages of 6 male broilers from 0 to 21 d. Based on an 8 h excreta collection at 19 d, AME of diets were determined. At 21 d one broiler per pen was killed and measurements of intestinal tract and viscosity of digesta determined. An unexpected outcome was that germination (42 h) was suppressed with potassium di-formate, whereas germination was achieved with grains soaked for 21 or 42 h. There were no significant effects of germination on growth and performance of broiler chicks. It was apparent from measurements of digesta viscosity that germination activated endogenous cereal xylanase and that reductions in viscosity increased with longer germination (particularly with potassium di-formate inclusion). These marginal results may relate to conditions applied during germination and/or drying that altered palatability of the wheat. The observation here that potassium di-formate suppressed germination, but still allowed endogenous enzyme activity to proceed may be a useful way of minimising respiration losses of nutrients, particularly energy, during germination.

**Key Words:** germination, wheat, broilers

**235 The effect of dietary L-carnitine on production and metabolism of broiler breeder hens reared using everyday or skip-a-day feed restriction programs.** M. de Beer\* and C. N. Coon, *University of Arkansas, Fayetteville.*

Feed restriction programs are used to control body weight and improve reproductive performance in breeder hens. L-carnitine is involved in fatty acid transport into mitochondria for subsequent oxidation. An experiment was conducted to determine the effect of dietary L-carnitine supplementation, for skip-a-day or everyday fed breeders, on production parameters, *in vitro* lipogenesis and stress. A total of 700 Cobb-Vantress broiler breeder pullets were randomly assigned to four groups in a 2x2 factorial experiment with two levels of carnitine (0 or 50 mg/kg) and two restriction programs (everyday or skip-a-day) with five replicate pens of 35 pullets per group. All pullets were fed *ad lib* until 10 days and then control fed everyday till 28 days. Restriction

programs were implemented at 28 days. All groups were fed every day after they reached 5% production. Pullets were photostimulated and individually housed in breeder cages at 21 weeks. Carnitine supplementation and everyday feeding improved feed efficiency during rearing. Everyday hens produced 3.40 more ( $P<0.05$ ) eggs/hen than skip-a-day hens at 42 weeks. Carnitine supplemented hens produced 3.2 more ( $P<0.05$ ) eggs than unsupplemented hens. Skip-a-day feeding and carnitine supplementation increased ( $P<0.05$ ) mean egg size by 1.37 and 1.31 g, respectively. Fertility was not affected by program or carnitine. Relative liver weight increased ( $P<0.05$ ) with skip-a-day feeding and added carnitine during rearing but differences were not evident after photostimulation. Skip-a-day feeding increased ( $P<0.05$ ) *in vitro* lipogenesis during rearing. Heterophil: lymphocyte ratios were used as an indicator of stress. Throughout rearing, skip-a-day restriction programs and carnitine supplementation increased ( $P<0.05$ ) H:L ratios. Skip-a-day feeding and added carnitine interacted to increase H:L at 40 weeks. Feed restriction program and carnitine supplementation can affect performance and other metabolic parameters in breeders.

**Key Words:** breeder, restriction, carnitine

**236 Evaluation of limit feeding low-energy diets for a varying number of days in a non-feed withdrawal laying hen molt program.** P. L. Utterback\*, E. J. Kim, C. M. King, K. W. Koelkebeck, and C. M. Parsons, *University of Illinois, Urbana.*

An experiment was conducted using 504 Hy-Line W-36 hens (69 wk of age) to evaluate three low-energy non-feed withdrawal molt diets fed for a varying number of days. Treatment 1 consisted of feed withdrawal for 10 d followed by feeding a 16% CP corn-soybean meal diet for 18 d. Treatment 2 consumed a 94% corn (Corn) diet for 35 d. Treatments 3, 4, and 5 received a 47% corn:47% soybean hulls diet (Corn:SH) for either 21, 28, or 35 days. Treatments 6 and 7 were fed a 71% wheat middlings:23% corn diet (WM:Cor) for either 21 or 28 days. At the end of the various molt periods, all hens were fed a 16% corn-soybean meal layer diet and production performance was measured for Weeks 1 to 28. Hens on the feed withdrawal treatment ceased egg production by Day 8. Treatments receiving the Corn:SH diet did reach 0% egg production by Day 10 but laid sporadically throughout the remainder each of their individual molt periods. However, treatments receiving the WM:Cor diet never reached 0% production. Body weight loss for hens on the feed withdrawal treatment was 25.2% on Day 10 of the molt period. On Day 21 of the molt period hens on the Corn:SH 21 and WM:Cor 21 treatments lost 13 and 2% of their original body weight, respectively. Hens on the Corn:SH 28 and WM:Cor 28 treatments lost 21 and 8% of their initial body weight. And, the hens fed the Corn and the Corn:SH 35 for 35 d lost 17 and 28% of their original body weight, respectively. Hen-day egg production was different ( $P < 0.05$ ) for Weeks 1 to 28, with the Corn treatment being statistically lower than all treatments except the Corn:SH 35 and WM:Cor 28 treatments. No consistent differences were observed among treatments for mortality, egg weight, egg specific gravity, and feed efficiency during the post-molt production period. When compared to a 10-d fast, this research indicates that a diet containing a combination of corn and soybean hulls fed for a varying number of days is an effective non-feed withdrawal method for molting laying hens.

**Key Words:** molt, laying hens, molt period

**237 Influence of cereal type, heat processing of the cereal, and inclusion of fiber in the diet on organ weights and ileal digestibility of nutrients in broilers.** E. Jiménez-Moreno, J. M. González-Alvarado, A. de Coca, R. Lázaro, and G. G. Mateos\*, *Universidad Politécnica de Madrid, Spain.*

The effects of diet composition on development of digestive organs and apparent ileal digestibility (AID) of nutrients were studied in 21 d old broilers. There were twelve treatments arranged factorially with two cereals (corn and rice), two processing methods (HP) (raw and cooked at 90°C from 50 min), and three fiber sources [none, 3% oat hulls (OH), and 3% soybean hulls (SH)]. Each treatment was replicated three times (a cage with 16 chicks). The control diets were based on cereal (60% of either corn or rice), soy protein concentrate, soy oil, and 1% celite, and the crude fiber content was 2.4% (corn diet) and 1.5% (rice diet). Relative weights (RW) of proventriculus (0.78 vs. 0.75% BW) and gizzard (3.28 vs. 2.84% BW) were higher for broilers fed corn than for broilers fed rice ( $P < 0.001$ ). HP of corn reduced

gizzard RW ( $P < 0.05$ ) whereas HP of rice did not have any effect. Oat hulls increased gizzard RW (3.37 vs. 2.96% BW;  $P < 0.001$ ) whereas SH increased proventriculus RW (0.78 vs. 0.74% BW;  $P < 0.001$ ). An interaction cereal  $\times$  hulls inclusion was detected; the increase in gizzard RW because of OH was higher for the rice- than for the corn- based diets ( $P < 0.05$ ). Hulls inclusion increased gizzard digesta content, an effect that was more pronounced in the rice- than in the corn- based diets ( $P < 0.001$ ). The AID of nutrients was higher for rice than for corn diets ( $P < 0.001$ ). An interaction cereal  $\times$  HP was observed; HP improved AID of DM and gross energy in the corn diets but had the opposite effects in the rice diets ( $P < 0.01$ ). Hulls inclusion improved AID of DM and gross energy ( $P < 0.05$ ) and the benefits observed were more pronounced with OH than with SH ( $P < 0.1$ ). We concluded that the inclusion of an insoluble fiber source to low-fiber diets stimulates gizzard function and improves nutrient utilization. Therefore, it is recommended to include a minimal amount of insoluble fiber in diets for young broilers.

**Key Words:** fiber inclusion, ileal digestibility, broiler

## Processing, Products, and Food Safety: Broiler Microbiology

**238 Growth of *Campylobacter* spp. in media supplemented with organic acids.** A. Hinton, Jr.\*, *Russell Research Center, Athens, Georgia.*

*Campylobacter* spp. are the main cause of bacterial foodborne illnesses in humans, and contaminated poultry products are major sources of campylobacteriosis. In this study, the growth of *Campylobacter* spp. in media supplemented with organic acids was examined. Tryptose-yeast extract basal broth medium was supplemented with 0, 10, 20, 30, 40, or 50 mM of citric, fumaric, lactic, malic, or succinic acid then inoculated with cultures of *Campylobacter coli* ATCC 33559, *Campylobacter fetus* subsp. *fetus* ATCC 27349, or *Campylobacter jejuni* subsp. *jejuni* ATCC 33560. Inoculated media were transferred into a MACS VA500 Microaerophilic Workstation, and 0.1 ml of the bacterial suspensions were dispensed into wells of a Honeycomb 2 cuvette plate. Each cuvette well was overlaid with 0.1 ml of sterile mineral oil, and the filled Honeycomb 2 plates were transferred to the incubator tray of a Bioscreen C Microbiology Reader. The microbiology reader measured the absorbance of the suspensions after cultures were incubated at 37°C for 48 h. Results indicated that growth of *C. coli* ATCC 33559 and *C. jejuni* subsp. *jejuni* ATCC 33560 were significantly ( $P < 0.05$ ) higher when cultured in media supplemented with 20 to 50 mM of either organic acid than when cultured in media not supplemented with an organic acid. Growth of *C. fetus* subsp. *fetus* ATCC 27349 was significantly ( $P < 0.05$ ) greater in media supplemented with 10 to 50 mM of either organic acid, except for citric acid, than in non-supplemented media. Growth of the *Campylobacter* isolates was also measured in basal media supplemented with a mixture of 10, 20, 30, 40, or 50 mM of fumaric, malic, lactic, and succinic acids utilizing the same methods used to examine growth in media supplemented with individual organic acids. Results indicated that the growth of all isolates was significantly ( $P < 0.05$ ) greater in media supplemented with mixtures containing 10 to 40 mM of each organic acid than in non-supplemented media. Findings of this study illustrate that growth of *Campylobacter* spp. may be enhanced when the bacteria are cultured in media supplemented with selected organic acids. These supplemented media may be useful in conducting research on

intervention methods for reducing contamination of poultry products by this pathogen.

**Key Words:** *Campylobacter*, media, organic acids

**239 Organic acid water treatment reduced *Salmonella* horizontal transmission in broiler chickens.** C. Knight\*<sup>1</sup>, C. Hofacre<sup>2</sup>, G. Mathis<sup>3</sup>, M. Quiroz<sup>1</sup>, and J. Dibner<sup>1</sup>, <sup>1</sup>*Novus International, Inc., St. Louis, Missouri*, <sup>2</sup>*Poultry Diagnostic & Research Center, Athens, Georgia*, <sup>3</sup>*Southern Poultry Research, Inc., Athens, Georgia.*

The purpose of the present study was to determine whether an organic acid water treatment could reduce the spread of *Salmonella* (SAL) to naïve birds when infected birds were part of the population. A total of one thousand eighty (1080), day-old Cobb X Cobb male chicks were allocated 60/pen to each of 18 pens by blocks and divided into three treatment groups: T1, unmedicated control; T2, 0.04%; and T3, 0.08% of an organic acid blend (OAB; ACTIVATE<sup>®</sup> US MAX). The OAB was added to water from 0-14 days and 42-49 days. Half of the birds in each pen were orally dosed with Naladixic acid resistant-S. heidelberg on Day 0 (tagged) and housed with the remaining uninfected birds (not tagged). *Salmonella* status of ceca and crops (Day 49 only) was evaluated by random selection of 5 tagged and 5 untagged birds/pen on days 0, 14 and 49. Dragswabs of pens were also obtained on the same days as was mortality, weight gain, feed consumption and feed conversion. On day 49, 22% of T1 untagged birds had SAL+ ceca compared to only 7% of T2 and T3 untagged birds ( $P < .05$ ). In addition, the %SAL+ crops of untagged birds and SAL+ dragswabs of the pens were significantly reduced for T2 and T3. There was no effect of OAB on % SAL+ ceca or crops for tagged birds. This finding is consistent with the hypothesis that the OAB have their primary antibacterial effects at low pH (upper gastrointestinal tract) and would tend to reduce survival and subsequent cecal colonization of SAL consumed by naïve birds but have no impact on SAL already present in the ceca. Feed conversion was improved ( $P < .05$ ) by OAB at 42 days of age (1.80 vs 1.77 and 1.77) and at 49 days similar trends were apparent (1.95 vs 1.90 and 1.91) but not different, nor were there differences in