

rations in juiciness, beef flavour intensity, abnormal flavour intensity or in the flavour attributes of greasy, bloody livery, metallic, bitter, sweet, rancid, fishy, acidic, cardboard or vegetable/grassy. It is concluded that while statistically significant, the absolute differences in colour and tenderness were small and may not be detected by consumers.

Key Words: beef colour, sensory

T163 The influence of forage diets and aging on beef palatability. T. Jiang*¹, J. R. Busboom¹, M. L. Nelson¹, J. O'Fallon¹, T. P. Ringkob², D. Joos², K. R. Rogers-Klette², and K. Piper², ¹Washington State University, Pullman, ²University of Nevada, Reno.

To investigate the influence of diet and aging on beef palatability (beef steak and ground beef), lipid oxidative stability, and fatty acid composition, crossbred steers were assigned in a Completely Randomized Design to dietary treatments of Feedlot S (finished on alfalfa and grain), Forage 1 (triticale and annual rye grass), Forage 2 (triticale and kale), or Combination (grazing rye, fescue and orchard, finished on alfalfa and grain). Heifers were finished on alfalfa and grain (Feedlot H). Two longissimus muscle steaks from five animals per dietary treatment and three trimmed triceps brachii muscle samples from four animals per dietary treatment were collected. Steaks were either dry- or wet-aged for 14d. Ground beef samples were dry-aged, or wet-aged for 14d, or not aged. Nine-member trained sensory panels were conducted to evaluate palatability attributes of beef steaks (beef flavor, off-flavor, initial tenderness, sustained tenderness, and juiciness) and ground beef (beef aroma, off-aroma, beef flavor, off-flavor, tenderness, and juiciness). There was no ($P > 0.05$) effect of diet or aging on cooking weight loss. Diet and aging treatment did not ($P > 0.05$) influence the palatability of beef steaks. Similarly, diet did not ($P > 0.05$) influence the palatability of ground beef. However, aging impacted ($P < 0.05$) ground beef sensory attributes and the influence depended on dietary treatment or possibly animal sex. In general, aging negatively affected ground beef palatability. Furthermore, dry-aging had more negative effects on palatability than wet-aging. Dietary and aging treatments had no ($P > 0.05$) impact on lipid oxidative stability of raw ground beef but affected the fatty acid composition. Therefore, to maintain ground beef palatability aging should not be practiced.

Key Words: beef palatability, beef aging, cattle diet

T164 Influence of management systems on meat quality of heifers fed with different lipid supplements in the finishing phase. M. C. A. Santana*¹, T. T. Berchielli¹, R. A. Reis¹, A. V. Pires², G. Fiorentini¹, and M. A. A. Balsalobre³, ¹São Paulo State University, Jaboticabal, São Paulo, Brazil, ²São Paulo University, Piracicaba, São Paulo, Brazil, ³Bellman, Mirassol, São Paulo, Brazil.

The feeding strategy is the management tool most widely used as a quality control method in the production conditions of meat. The areas of focus in this experiment are colors a, b, L and shear force (WBSF), water-holding capacity (WHC), pH and cooking loss percentage (Closs) in meat from heifers fed with different lipid supplements in the finishing phase system. The experiment was completely random design, using a 3×2 factorial arrangement (3 supplements and 2 systems). The supplements came from 3 different sources; soybean grains, soybean oil and protected fat (MEGALAC-E), the two finishing phase systems came from pasture (0.75% of BW) or feedlot (60:40 concentrate: corn silage). The treatments were compared by analyzing variables using the GLM procedure (SAS 9.1, SAS Institute, Inc., Cary, NC). Mean values were compared using the Tukey test at a significance level of 0, 05. Using a colorimeter, the color of the longissimus muscle (LM) at the 12th and 13th rib interface in the $L^*a^*b^*$ color space (CIE system) was determined. A time span of 30 minutes was awaited before color analysis. The WBSF was obtained from steaks previously thawed and roasted using an insert thermometer until 70°C was obtained. Later, the samples were cut into cubes; the data collected was achieved using a Warner-Bratzler shear machine. The muscle pH (pHu) measurements were taken from the interior of the LM at 24 h postmortem using a portable pH meter. The water holding capacity was obtained by determining the difference of the sample weights under 10 kg of pressure for 5 minutes. The cooking loss value was determined according to the reduced percentage rate before and after the meat was cooked. The meat attributes were not influenced by the supplements, however, the meat from the pasture systems showed a significantly higher grade in muscle pH as well as in colors a and L. The results of this experiment confirm that the feeding strategy used can in fact influence the quality of meat by altering the pH and color (a,L).

Table 1. Means for the colours a, b and L, meat pHu, water-holding capacity (WHC), pH and percentage cooking loss (Closs) and shear force (WBSF) of heifer's meat from finishing phase systems, pasture and feedlot.

Systems	Color a	Color b	Color L	pHu	WHC	Closs	WBSF
Feedlot	16,58 b	3,59 a	34,62 b	5,64 b	72,30 a	33,74 a	7,54 a
Pasture	18,17 a	3,77 a	36,96 a	5,72 a	73,23 a	33,19 a	7,99 a

Means followed by different letters in the same column are different ($P < 0.05$).

Key Words: pasture, feedlot, lipids

Nonruminant Nutrition: Feed Additives I

T165 Hypocholestromic effect of turmeric powder and sodium selenite in Ross broilers reared under heat stress conditions. A. Zeinali*¹, A. Riasi¹, H. Farhangfar¹, and H. Ziaei², ¹Birjand University, Birjand, Iran, ²Agricultural Research Center, Birjand, Iran.

An experiment was conducted using 180 Ross broiler chickens to evaluate the effect of different levels of sodium selenite (SS) and turmeric powder (TP) on lipid concentrations of broilers. One-day old chicks were randomly allocated to 6 treatments (T1= control, T2= control + 5 g TP /kg, T3= control + 10 g TP /kg, T4= control + 0.3 mg Se/kg,

T5= control + 0.3 mg Se + 5 g TP/kg, and T6= control + 0.3 mg Se + 10 g TP /kg) with 3 replicates and 10 birds per each replicate. The air temperature was increased (32-35°C) from day 28 to day 42. At 28 and 42 d of age, two birds (one male and one female) of each replicate were randomly selected and blood samples were taken from the wing vein with heparinized syringes. Statistical analysis of data was undertaken using the GLM procedure of SAS. Results showed that the interaction between selenium and turmeric powder resulted in a decrease in plasma cholesterol concentration at 28 days of age ($P < 0.05$). Birds fed the

control diet and T3 had the highest and lowest concentration of cholesterol respectively (120.0 mg/ml versus 99.5 mg/ml) and no difference was found between T3 and T6. At 42 days of age, T6 had the lowest cholesterol concentration. Repeated measurement analysis showed that the effect of sampling time on the difference between treatments was significant ($P < 0.05$). At 28 days of age, supplementation of diets with sodium selenite and turmeric powder significantly decreased triglyceride concentration ($P < 0.05$), but this difference was not significant at 42 days of age. In conclusion, using turmeric powder (10 g/kg diet) and sodium selenite (0.3 mg/kg diet) could reduce the cholesterol level of serum of broilers under heat stress conditions.

Key Words: broiler, serum lipid, heat stress

T166 Cloning and expression of porcine carboxypeptidase A1 for feed application. Y. Zhao¹, H. Zhao¹, J. C. Zhou¹, X. J. Xia¹, and X. G. Lei^{*1,2}, ¹Int. Ctr of Future Agriculture for Human Health, Sichuan Agri. Univ., Ya'an 625014, China, ²Cornell University, Ithaca, NY.

Carboxypeptidase A (CPA1, EC 3.4.16) is a digestive enzyme that hydrolyzes peptide bonds nearest to the terminal carbonyl group in polypeptide chains. The enzyme can be used to improve feed protein digestion by young animals. To produce recombinant porcine pancreatic proCPA1, the full-length cDNA of porcine carboxypeptidase A gene was isolated from porcine pancreas by RACE and cloned into the pPICZaA vector (Invitrogen, Shanghai, China). The DNA construct was transformed into *Pichia pastoris* X33 cells. Transformants with high-level expression were selected by Syber-green quantitative real-time RT-PCR Analysis (ABI 7900HT, Applied Biosystems, Foster City, CA). The extracellular recombinant proCPA1 contained a histidine tag in the C terminus and was purified using Ni-Sepharose affinity chromatography (GE Healthcare, Piscataway, NJ). The purified protein exhibited a molecular mass of approximately 47 kDa as determined by SDS-PAGE analysis. Western blot analysis using an anti-porcine carboxypeptidase A antibody and peptide mass fingerprint analysis confirmed the purified 47 kDa protein as the target enzyme. In conclusion, the successful production of the recombinant proCPA1 in *P. pastoris* enabled further functional study of the enzyme in animal feeding. This project was supported by the 863 Program of the State High-Tech Development Plan funded and administered by the government of the People's Republic of China (2007AA100601-6).

Key Words: porcine, *Pichia pastoris*, enzyme

T167 Determination of optimal conditions for hydrolysis of conjugated deoxynivalenol in corn and wheat with trifluoromethanesulfonic acid. S.-T. Tran* and T. K. Smith, *University of Guelph, Guelph, Ontario, Canada.*

Deoxynivalenol (DON, vomitoxin), is a common type B trichothecene mycotoxin produced by many *Fusarium* species and is found as a contaminant of crops worldwide. DON can reduce production efficiency and cause serious economic losses to livestock and poultry producers. Recent studies have suggested that common analytical methods for DON analysis in feedstuffs do not detect conjugated (masked) mycotoxins. The aim of the current study, therefore, was to determine the optimal conditions in which non-extractable (conjugated) DON in corn and wheat can be hydrolyzed by trifluoromethanesulfonic acid (TFMSA) which has been reported to deglycosylate glycoproteins regardless of linkage and composition. The optimal hydrolysis procedure was determined based

on reaction time, reaction temperature and TFMSA concentration. Total DON concentrations were determined using ELISA kits (AgraQuant® DON kit). The optimal hydrolysis conditions for determination of conjugated DON in corn were found to be 0.5N TFMSA incubated for 20 min at 22°C. Optimal conditions for wheat samples were 0.5N TFMSA incubated for 40 min at 40°C. Using these optimal hydrolysis conditions, 6 naturally contaminated corn samples and 5 naturally contaminated wheat samples were analyzed to determine the presence of conjugated DON. All samples contained conjugated DON in significant amounts with an increase of 17-69% of DON in corn following hydrolysis and an increase of 21-72% of DON in wheat following hydrolysis. It can be concluded that the optimal conditions for TFMSA hydrolysis of conjugated DON in corn and wheat have been determined and that this will be useful in accurately determining total DON content of grains and detection of conjugated DON in feeds and foodstuffs.

Key Words: *Fusarium* spp., conjugated deoxynivalenol, trifluoromethanesulfonic acid

T168 Efficacy of a commercial purified phyllosilicate in preventing fumonisin toxicity in finishing pigs. C. A. Mallmann¹, P. Dilkin¹, L. Giacomini¹, R. H. Rauber¹, and J. Garcia-Sirera^{*2}, ¹Universidade Federal de Santa Maria, Laboratório de Análises Micotoxicológicas (LAMIC), Santa Maria, RS, Brasil, ²Special Nutrients, Miami, FL.

Two experiments of different lengths of time (28 and 56 days) were conducted to study the efficacy of a commercial purified phyllosilicate (Myco-Ad A-Z) in preventing the deleterious effects of fumonisin (FUM) in finishing pigs. Twelve male pigs averaging 58.5 kg initial body weight were used in each experiment. Pigs were individually housed and randomly distributed into 3 dietary treatments with 4 replications and fed corn-SBM diets meeting or exceeding NRC recommendations. All ingredients used tested free of mycotoxin contamination. Treatments were: (1) control diet; (2) control + 25 ppm FUM; and (3) control + 25 ppm FUM + 4.0 kg/mt Myco-Ad A-Z. FUM was obtained from a culture material containing 72% FUM B1 and 28% FUM B2 produced in LAMIC. Performance and organs (lungs, heart and liver) relative weights (g/kg body weight) were evaluated in experiment 1 (EX1). Performance, relative weight of lungs and serum sphinganine / sphingosine ratio (SA:SO) were determined in experiment 2 (EX2). Results from both experiments showed that pigs fed 25 ppm FUM had significantly ($P \leq 0.05$) poorer performance; increased relative weights of lungs, heart and liver, and increased serum SA:SO than pigs fed the control diet. The addition of Myco-Ad A-Z to the contaminated diet significantly ($P \leq 0.05$) improved performance parameters and relative organ weights, feed intake (2615 vs 2315 g EX1) (2948 vs 2810 g EX2), daily gain (861 vs 722 g EX1) (1084 vs 996 g EX2), feed efficiency (2.70 vs 3.08 EX1) (3.21 vs 3.46 EX2), lungs (6.68 vs 9.69 EX1) (5.94 vs 6.34 EX2), heart (3.75 vs 4.87 EX1), and liver (18.65 vs 20.89 EX1). Serum SA:SO, a key marker of FUM toxicity, was significantly ($P \leq 0.05$) increased in pigs fed FUM compared to control and Myco-Ad A-Z fed pigs (0.78 vs 0.38 and 0.49). These results indicate that Myco-Ad A-Z was very effective in preventing the toxic effects of FUM in finishing pigs.

Key Words: Myco-Ad A-Z, fumonisin, pigs

T169 Development and validation of an analysis method for carvacrol encapsulated in different matrixes and set in pelleted feed. S. Oguey*, A. Vienne, C. Ionescu, and D. Bravo, *Pancosma, Geneva, Switzerland.*

Carvacrol, the active compound of oregano, was encapsulated into different matrixes and technologies in order to determine the most efficient way to protect it during the feed manufacturing process and storage. It was necessary to develop and validate a new analytical method for the carvacrol formulations in feed. Most of the encapsulation matrixes tested were polar, while carvacrol had a much lower polarity. The challenge was to dissolve the encapsulation and carvacrol at the same time. The initial carvacrol concentration in the feed was around 1 g/kg. A single method was developed for all carvacrol formulations. Accelerated solvent extraction (ASE) was used for the extraction. The separation and quantification was done by gas chromatography with a flame ionisation detector (GC-FID). Twenty grams of sample were weighed in a 33 mL extraction cell and extracted with methanol at 110°C and 100 bar. The Flush was set at 10%, the static time was 19 minutes with 2 cycles. The heat time was set to 6 minutes. Each extraction cell was extracted 3 times and the extracts were transferred in a 200 mL flask. The solution was filtered and analysed by GC-FID with a capillary column ZB-5ms 20 m × 0.18 mm × 0.36 mm. The split ratio was 1:10 and 1 mL was injected. The injector and detector temperature were respectively set at 250°C and 300°C. The carrier gas was helium and the flow rate was 0.8 mL/min. The temperature program started at 100°C for 1 min, then a 15°C/min gradient was applied up to 180°C and a second one to 300 at 50°C/min and kept at 300°C for 30 s. The method proved to be valid for all tested formulations in feed, the carvacrol solutions were stable for 36 days (R^2 of the calibration curve > 0.999). The application range was far over the quantification limit and was in the linear range, the repeatability had a RSD < 10%, the method was true with a normalised deviation < 1 and the extraction yield was > 98.5%. This method allowed a precise comparison of the carvacrol stability depending on the encapsulation.

Key Words: essential oil, encapsulation, traceability

T170 Heterologous expression of recombinant porcine elastase 2 as a feed enzyme. Y. J. Zhang¹, H. Zhao¹, J. C. Zhou¹, X. J. Xia¹, and X. G. Lei^{*1,2}, ¹*Int. Ctr of Future Agriculture for Human Health, Sichuan Agri. Univ., Ya'an 625014, China,* ²*Cornell University, Ithaca, NY.*

Porcine pancreatic elastase is a protease that specifically degrades insoluble elastin. A recombinant elastase can be used to improve feed protein utilization by swine and poultry. The objective of this study was to develop an efficient expression system to produce porcine elastase 2. A cDNA fragment encoding the proELA2 was isolated from porcine pancreas by RT-PCR and cloned into the pPICZaA (Invitrogen, Shanghai, China) expressing vector. The pPICZaA-proELA2 construct was transformed into *Pichia pastoris* KM71 cells. The transformants were screened by Syber-green quantitative real-time RT-PCR (ABI 7900HT, Applied Biosystems, Foster City, CA). After 72-h of 0.5% methanol induction, the extracellular proELA2 protein containing a histidine tag appended to the C terminus was purified using Ni Sepharose High Performance affinity column (GE Healthcare, Piscataway, NJ). The purified protein had a molecular mass of approximately 31 kDa as determined by SDS-PAGE analysis, and was verified by both Western blot and peptide mass fingerprint analyses. After optimizing the medium temperature and methanol induction procedure, a yield of 45 mg of recombinant proELA2 per liter was obtained. In summary, the recombinant porcine pancreatic proelastase2 was expressed extracellularly at a relative high level under the control of AOX1 promoter in *Pichia pastoris*.

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Key Words: Porcine, feed enzyme, *Pichia pastoris*

T171 Expression and purification of porcine pancreatic carboxypeptidase B in a yeast system. Y. Liu¹, H. Zhao¹, J. C. Zhou¹, X. J. Xia¹, and X. G. Lei^{*1,2}, ¹*Int. Ctr of Future Agriculture for Human Health, Sichuan Agri. Univ., Ya'an, China,* ²*Cornell University, Ithaca, NY.*

Pancreatic carboxypeptidase B (CPB) is a key enzyme highly specific for excising C-terminal lysine and arginine from peptides and proteins, and can be used as a feed additive to improve protein digestion by animals. To express the recombinant proCPB at high level in *Pichia pastoris*, a cDNA fragment encoding the porcine pancreatic proCPB along with its own secretion signal peptide was cloned into the pPICZaA vector (Invitrogen, Shanghai, China) under the control of AOX1 promoter. The recombinant proCPB protein contained a histidine sequence appended to the C terminus and was purified from the supernatant by the immobilized metal ion affinity chromatography (Ni-NTA Sepharose (GE Healthcare, Piscataway, NJ)). The extracellular enzyme showed a molecular mass of approximately 47 kDa as determined by SDS-PAGE analysis. The identity of the enzyme was verified by both Western blot and peptide mass fingerprint analyses. In conclusion, the recombinant proCPB was successfully expressed in *P. pastoris* as an extracellular enzyme. *This project was supported by the 863 Program of the State High-Tech Development Plan funded and administered by the government of the People's Republic of China (2007AA100601-6).*

Key Words: porcine, pancreatic carboxypeptidase B, *Pichia pastoris*

T172 Effects of antioxidants on growth performance and antioxidant status of broiler chickens. Y. Zou, Z. B. Yang*, W. R. Yang, S. Z. Jiang, and G. G. Zhang, *Shandong Agricultural University, Tai'an, Shandong, P. R. China.*

The experiment was designed to assess the effects of two kinds of antioxidants provided by Novus International, Inc., SQ M6 (Santoquin M6) and SQ Max (Santoquin Max), on growth performance and antioxidant status in broiler chickens. A total of 96 day-old AA broilers were randomly allocated to three treatments: 1) the control group: a basal diet without supplementation of any antioxidants; 2) SQ M6 (48 mg/kg) supplemented group; 3) SQMax (80 mg/kg) supplemented group. There were 4 replicate pens per treatment and 8 birds each. The birds were housed in 12 wire pens in an environmentally controlled room with artificial lighting (24hrs), and fed *ad libitum* with a starter diet from 1 to 28 days of age. Body weight and feed intake of chicks of each pen were measured weekly for determination of average daily gain (ADG), average daily feed intake (ADFI), and feed conversion rate (FCR). Blood samples were taken from 16 birds (4 birds each replicate) at the end of the experiment to determine the antioxidant status of the birds, including activities of total Cu-Zn superoxide dismutase (Cu-Zn SOD) and total anti-oxidation capability (T-AOC), and serum malondialdehyde (MDA) concentration. The results showed that there was no significant difference in performance (ADG, DMI or FCR) between different treatment groups (Table 1). SQ M6 improved ADG and FCR numerically in broilers as compared with both control and SQ Max supplemented group. However, supplementation of antioxidants significantly increased ($P < 0.05$) activities of Cu-Zn SOD and T-AOC, and reduced ($P < 0.05$)

serum MDA concentrations in broilers. Compared with the control group, dietary addition of SQ M6 and SQ Max significantly improved the Cu-Zn SOD (29.63% and 33.33% respectively), T-AOC (6.39% and 31.72% respectively), and decreased serum MDA levels (15.49% and 11.10%, respectively). Supplementation of SQ M6 and SQ Max, had no significant effects on growth performance of broiler chickens. However, of the three treatment groups, SQ M6 supplemented birds showed better growth rate and lower FCR. Both SQ M6 and SQ Max significantly improved antioxidant status of broilers.

Table 1. Effects of antioxidants on performance and antioxidant status in broiler chickens

Results	Control	SQ M6	SQ Max
ADG , g/d	36.92	38.15	36.74
ADFI , g/d	72.32	68.62	69.18
FCR	1.58	1.45	1.52
SOD, U/mg	61.63 ^a	79.89 ^b	82.17 ^b
T-AOC, U/ml	7.00 ^a	7.45 ^a	9.22 ^b
MDA, nmol/ml	4.66 ^a	3.94 ^b	4.14 ^{ab}

^{abc}different superscript letters within the same row represent a significant difference between treatments (P<0.05).

Key Words: antioxidant, broilers growth, antioxidant status

T173 Comparative effects of *Escherichia coli* AppA2 and *Aspergillus niger* PhyA phytases on bone property of weanling pigs fed a high phosphorus diet. C. E. Mills, C. A. Faber, K. R. Roneker, and X. G. Lei*, *Cornell University, Ithaca, NY.*

Enhancing peak bone mass in early life may reduce bone degenerative diseases such as osteoporosis in later life. Previous research in our laboratory has demonstrated potential benefits of supplementing high levels of *Escherichia coli* AppA2 phytase to bone metabolism in young pigs fed phosphorus-adequate diets. The objective of this study was to compare effects of AppA2 with those of *Aspergillus niger* PhyA on bone characteristics of weanling pigs. A total of 30 crossbreds (3-week old, Yorkshire-Landrace-Hampshire crossbred) were allotted to three groups (n = 10) and fed a corn-soybean-mean basal diet (BD, supplemented with 0.35% inorganic phosphorus), the BD plus 3,500 units of AppA2/kg (Optiphos, JBS United, Sheridan, IN), or the BD plus 3,500 units of PhyA/kg (Natuphos, BASF, Florham Park, NJ) for six weeks. All pigs were bled biweekly for assays of plasma inorganic phosphorus concentration and alkaline phosphatase activity. Eight pigs of each treatment group were killed at the end of the study to collect the right femur and humerus for biomechanics analyses. Compared with those fed BD, Pigs fed AppA2 showed 25% higher plasma alkaline phosphatase activity at week 4 (P < 0.05) and week 6 (P = 0.08). Pigs fed PhyA displayed a 13% increase (P = 0.06) in the maximal load of humerus and a 14% increase (P < 0.01) in femoral cortical thickness than pigs fed BD. In conclusion, AppA2 and PhyA seemed to exert different impacts on bone biochemical and biomechanics measures of young pigs fed the high phosphorus diet.

Key Words: alkaline phosphatase, biomechanics, phytase

T174 Effects of dietary marine microbe accumulating ω -3 fatty acid supplementation on growth performance and carcass characteristics in finishing pigs. H. J. Kim*, T. X. Zhou¹, J. H. Jung¹, M. S. Ryu², H.

J. Kim², and I. H. Kim¹, ¹*Dankook University, Cheonan, Choongnam, Korea,* ²*JINIS Inc, Wanju, Jeonbuk, Korea.*

This study was conducted to investigate the effects of dietary marine microbe accumulating ω -3 fatty acid supplementation on growth performance and carcass traits in finishing pigs. A total of 96 pigs (73.01 kg, average initial body weight) were used during 42 days. Dietary treatments included: 1) CON (basal diet), 2) M2 [basal diet + 0.2% marine microbe (*Ostreococcus tauri*) accumulating ω -3 fatty acid] and 3) M4 [basal diet + 0.4% marine microbe (*Ostreococcus tauri*) accumulating ω -3 fatty acid]. Each treatment had 8 replicates of 4 pigs per pen in a randomized complete block design. In growth performance, ADFI was higher (P<0.05) in M2 treatment than CON and M4 treatments. In meat color, redness (a*) was significantly higher in M4 treatment than CON treatment and yellowness (b*) was significantly lower in marine microbe groups than CON treatment. In sensory evaluation, color score of M4 treatment was improved compared with CON and M2 treatments. Drip loss was significantly higher in M4 treatment than CON treatment at 1 day and was significantly higher in CON and M4 treatments than M2 treatment. Meat pH was significantly higher in M4 treatment than CON and M2 treatments. Total mono-unsaturated fatty acid content was significantly higher in marine microbe groups than CON treatment. Total ω -6 fatty acid content was significantly lower in marine microbe groups than CON treatment (P < 0.05). Total ω -3 fatty acid content was significantly highest in M4 treatment among treatments and was significantly lowest in CON treatment. Total ω -6/ ω -3 ratio was significantly higher in M2 treatment than M4 treatment. In conclusion, dietary marine microbe accumulating ω -3 fatty acid supplementation improved meat color and fatty acid content.

Key Words: marine microbe, carcass trait, ω -3 fatty acid

T175 Comparative effects of phytase derived from *Escherichia coli* and *Aspergillus niger* in laying hens. L. Yan*¹, H. D. Jang¹, S. M. Hong¹, H. S. Kim², Y. Hyun², and I. H. Kim¹, ¹*Dankook University, Cheonan, Choongnam, Korea,* ²*Seoul Feed, Co. LTD, Seoul, Korea.*

A total of two hundred and sixteen 68-week-old Hy-Line brown laying hens were used in a 6-week feeding trial to compare the efficacy of phytase Optiphos (OPT) and Natuphos (NAT), which were isolated from the strain of *Escherichia coli* and *Aspergillus niger*, respectively. Hens were randomly allotted into six treatments with six replications (six layers in adjacent three cages) per treatment according to the initial BW. Dietary treatments including: 1) PC (basal diet + available phosphorus (AP) 0.4%); 2) NC (basal diet + AP 0.2%); 3) NP1 (NC + 250 FTU/kg NAT); 4) NP2 (NC + 500 FTU/kg NAT); 5) OP1 (NC + 250 FTU/kg OPT); 6) OP2 (NC + 500 FTU/kg OPT). Feed intake, egg production, egg quality, nutrients apparent digestibility, and serum P and Ca concentration were investigated to compare the effect of the two phytases. In the current study, feed intake and eggshell thickness were not affected by the treatments. Superior effects (P<0.05) of OPT were only observed in egg production and egg weight compared with NAT in this experiment. Both phytases were equally effective in increasing (P<0.05) eggshell breaking strength, apparent digestibility of N, Ca, P and serum P concentration, whereas no significant difference was observed in the contrast between PC and phytase supplementation at 500 FTU/kg to the NC diet. Equally effective improvements were also observed in egg production and DM digestibility (P<0.05), but those were not as high as that in PC treatment with the phytase supplementation at 500 FTU/kg. Both phytases equally increased serum Ca compared to the PC. However, a linear effect was only observed for the OPT treatment. Data from the study suggest that NAT and OPT are equally effective in liberating phytate-bound complex

when included in P-deficient diets for 68-week-old laying hens. Either source can be fed to commercial laying hens to improve phytate-bound nutrients utilization.

Key Words: phytase, laying hens, comparative

T176 Effects of cysteamine to replace antibiotics on growth performance and nutrient digestibility in weaning pigs. J. H. Jung*, T. X. Zhou, L. Yan, S. M. Hong, and I. H. Kim, *Dankook University, Cheonan, Choongnam, Korea.*

This study was conducted to evaluate the effects of cysteamine to replace antibiotics on growth performance and nutrient digestibility in weaning pigs. A total of eighty pigs [(Landrace×Yorkshire)×Duroc] (initial body weight 6.95 ± 0.48 kg) were used for the 42 day feeding trial. Dietary treatments included 1) CON (basal diet), 2) ANT (phase 1 : basal diet with 40ppm of avilamycin and 100ppm of OTC; phase 2, phase 3 : basal diet + 100ppm of avilamycin and 40ppm of chlortetracy), 3) CYS0.05 (basal diet + cysteamine 0.05%) and 4) CYS0.1 (basal diet + cysteamine 0.1%). There were four dietary treatments with four replicate pens per treatment and five pigs per pen. ADG in phase 2, 3 and overall periods, for ANT, CYS0.05 and CYS0.1 treatments were higher than Con treatment ($p < 0.05$). During the whole experimental period, no significant differences were observed in ADFI, while G:F ratio was lower in the CON treatment than other treatments ($p < 0.05$) during phase 2. ANT and CYS0.1 treatments had higher dry matter and nitrogen digestibilities compared to CON and CYS0.05 treatments at 3 and 6 weeks ($p < 0.05$). No significant differences were observed in blood characteristic values among treatments. The results of this experiment indicated that dietary supplementation of cysteamine 0.1%, improved ADG and nutrient digestibility in weanling pigs.

Key Words: cysteamine, digestibility, weaning pigs

T177 Effects of different dietary combinations of antibiotics, benzoic acid and probiotic for weaning pigs. G. F. Lopes¹, L. Alebrante¹, D. L. Santos¹, G. G. Garcia², A. A. Passos^{*3}, R. Balestrin³, and G. J. M. Lima⁴, ¹Vitamix Animal Nutrition, ²Santa Maria Federal University, ³DSM, ⁴Embrapa.

This study was conducted to evaluate different combinations of growth promoters. Four classes of antibiotics (AT) were used (colistin sulphate-CS, bacitracin methylene disalicylate-BD, neomycin sulfate-NS, tetracycline-TC) in association with benzoic acid (BA) and probiotic (*Enterococcus faecium*-EF). Seventy-two piglets (21 day old, 6.7 kg live wt) were sorted across three treatments and 12 replicates (2 piglets per pen) according to a randomized block design. Diets were divided in three phases: 1 - weeks 1 and 2; 2 - weeks 3 and 4; 3 - weeks 5 and 6 of experiment. Treatments were defined as: A - phase 1 diet with CS (160 ppm) + BD (55 ppm), phase 2 diet with CS (100 ppm) + TC (250 ppm) and phase 3 diet with NS (108 ppm) + BD (55 ppm); B - all phase diets with CS (40 ppm) + BA (5 kg/ton); C - all phase diets with CS (40 ppm) + BA (5 kg/ton) + EF (1.4×10^9 CFU/g). Average daily gain (ADG), feed intake (ADFI) and feed conversion ratio (FC) were measured every week considering accumulated data. Piglets fed C had greater ADG ($P < 0.1$) compared to A during the first week. ADG did not differ ($P > 0.1$) among treatments after that. There were no differences ($P > 0.1$) in ADFI and FC among treatments at any week. A combination of AT, BA and EF was most effective during the early weaning period. However, there were no differences between treatments for the entire nursery period.

Table 1. Effects of combining different growth promoters on post weaning pigs

	Treatment	Week					
		1	2	3	4	5	6
ADG g/d	A	153 ^a	269	352	413	467	511
	B	198 ^{ab}	295	348	413	471	521
	C	209 ^b	271	330	401	456	504
	sd	0.07	0.06	0.06	0.06	0.06	0.06
ADFI g/d	A	236	378	517	624	743	842
	B	297	408	529	657	780	886
	C	285	390	516	635	750	859
	sd	0.08	0.06	0.07	0.08	0.08	0.09
FC	A	1.94	1.47	1.50	1.52	1.60	1.65
	B	1.60	1.40	1.53	1.60	1.67	1.71
	C	1.47	1.46	1.57	1.59	1.65	1.71
	sd	0.63	0.18	0.14	0.14	0.13	0.10

^{ab}Means within column followed by different letters are different – Tukey ($P < 0.1$) sd – Standard Deviation

Key Words: piglet, acidifier, probiotic

T178 Effect of phytase supplementation on the calcium and phosphorus balance in adult cannulated ganders. J. Tossenberger¹, L. Babinszky^{*1}, and D. Feuerstein^{2,3}, ¹Kaposvár University, Kaposvár, Hungary, ²BASF SE, Ludwigshafen, Germany.

The objective of this study was to determine the effect of dietary phytase supplementation on P and Ca digestibility and urinary excretion in adult ganders. The trials used 4 hybrid ganders per treatment (Trt) in 2 replicates (8 birds/Trt, initial LW: 4.4 ± 0.5 kg). Prior to the trial a simple T-cannula was implanted in the terminal colon for separate quantitative collection of feces and urine. Basal diets were formulated on a corn-soybean basis. Diets in Trts 1,2,3,4 contained no P_i (P:3.4, Ca 4.4 g/kg) and were supplemented with phytase (3-phytase, from *Aspergillus niger*) at the rate of 0 (negative control=NC), 150, 300 and 450 FTU/kg. No phytase was added to the Trt 5 diet (positive control=PC); its P and Ca content met the NRC (1994) recommendations. Measured phytase activity of the diets was <70, 210, 270, 510 and <70 FTU/kg. Data were analyzed by ANOVA and regression analysis (SAS, 2004). Phytase supplementation of 150 FTU/kg improve P digestibility from 42.1 to 50.2% ($P < 0.05$). The supplementation with 300 and 450 FTU/kg phytase improved P digestibility by 10.4 and 13.5%, compared to the NC (42.1% vs. 52.5% & 55.6%) ($P < 0.05$). P digestibility in the PC group was 54.6%. Trt did not affect Ca digestibility ($P > 0.05$). Urinary P excretion was lowest in NC birds (13 mg/kg^{0.75}/d). A 150 FTU/kg phytase supplementation increased P excretion by 57% ($P < 0.05$). A phytase supplementation of 300 and 450 FTU/kg increased urinary P excretion by 47.3% and 64.1%, compared to NC ($P < 0.05$). Urinary P excretion of PC birds was 32 mg/kg^{0.75}/d. In contrast to P retention of NC birds (33.6%), phytase supplementation improved it up to 36.9%, 39.9% and 41.7% ($P < 0.05$). Higher phytase dosages resulted higher P retention (except in Trt 4) ($P < 0.05$). Ca retention was the same in all Trts ($P > 0.05$). The data show that supplementing 3-phytase from *Aspergillus niger* to corn-soybean based geese diets at levels between 150 and 450 FTU/kg increased their digestible P content ($P < 0.05$).

Key Words: digestibility, goose, phosphorous

T179 Genetic engineering of an *Escherichia coli* mutant phytase for thermostability does not affect the enzymatic efficacy in a diet for young pigs. L. E. Denmark, J. D. Weaver, K. R. Roneker, and X. G. Lei*, *Cornell University, Ithaca, NY.*

Previous protein engineering research in this laboratory has yielded an *Escherichia coli* AppA2 mutant phytase with improved thermostability and an *Aspergillus niger* PhyA mutant phytase with improved thermostability and pH profile. The objective of this study was to determine the effectiveness of these phytase variants in improving phytate phosphorus utilization by weanling pigs. A total of 40 pigs (5-week old, Yorkshire-Landrace-Hampshire crossbred) were fed a corn-soybean meal based basal diet (BD, without supplemental inorganic phosphorus) or the BD supplemented with the wild-type of AppA2, the AppA2 mutant, or the PhyA mutant at 300 U/kg of diet for four weeks. The phytase activity was assayed using the molybdenum blue method in 0.2 M citrate buffer, pH 5.5 with 5.4 mM sodium-phytate as substrate. Pigs (n = 10/treatment) were housed individually and had *ad libitum* access to feed and water. Daily feed intake and weekly body weight change of individual pigs were recorded, and blood samples of individual pigs were taken weekly to measure plasma inorganic phosphorus concentrations and alkaline phosphatase activity. Pigs fed the wild-type and the AppA2 mutant phytases had higher ($P < 0.01$) plasma inorganic phosphorus concentrations from week 2 through week 4 and lower ($P < 0.05$) plasma alkaline phosphatase activity in week 4 than did pigs fed the BD or the PhyA mutant. The latter two groups showed similar values in these measures. The overall growth performance of pigs was not affected by the dietary treatments. In conclusion, the AppA2 mutant phytase engineered for improved thermostability was as effective as the wild-type in releasing phytate-phosphorus from the diet for weanling pigs. The feeding performance of the PhyA mutant reinforces the difficulty in predicting nutritional value of recombinant enzymes.

Key Words: phytase, thermostability, pH

T180 The effects of lactose inclusion and seaweed sugars on performance, nutrient digestibility and microbial populations in newly weaned piglets. J. V. O'Doherty*, S. Dillon, J. J. Callan, and T. Sweeney, *University College Dublin, Belfield, Dublin 4, Ireland.*

A 2 x 2 factorial experiment was conducted to investigate the interactions between 2 different lactose levels (150 g/kg vs. 250 g/kg) and seaweed extract (containing laminarin and fucoidan) derived from *Laminaria* spp on growth performance, nutrient digestibility and fecal microbial population in the weanling pig. Two hundred and forty piglets were selected after weaning (24 days of age, 7.6 kg (s.d 0.9 kg) live weight) and blocked on the basis of live weight and within each block assigned to one of four dietary treatments. The piglets were offered the following diets *ad-libitum* for 25 days: 1) 150 g/kg lactose 2) 150 g/kg lactose plus seaweed extract; 3) 250 g/kg lactose; 4) 250 g/kg lactose plus seaweed extract. Piglets offered diets supplemented with seaweed extract had a higher average daily gain (ADG) (0.322 vs. 0.281 kg, s.e. \pm 0.009) ($P < 0.01$) and gain to feed ratio (0.669 vs. 0.611 kg/kg, s.e. \pm 0.019) ($P < 0.05$) between days 0-25 compared with piglets offered unsupplemented seaweed extract diets. Piglets offered high lactose diets had a higher ADG (0.319 vs. 0.283 kg, s.e. \pm 0.009) ($P < 0.05$) and average daily feed intake between days 0-25 (0.480 vs. 0.447 kg, s.e. \pm 0.011) ($P < 0.05$) compared with piglets offered the low lactose diets. The inclusion of seaweed extract increased ($P < 0.001$) the apparent digestibility of nitrogen (N Dig) and gross energy (GE Dig) and decreased fecal *E. coli* populations compared with unsupplemented seaweed extract diets. Piglets offered the high lactose diets had increased GE dig ($P < 0.001$)

N dig ($P < 0.05$) and decreased fecal *E. coli* populations compared with piglets offered low lactose diets. In conclusion, the inclusion of either a high dietary concentration of lactose or a laminarin-fucoidan extract increased daily gain and gain to feed ratio of post weaned piglets through an increase in nutrient digestibility and decreased *E. coli* populations in the gut.

Key Words: laminarin, fucoidan, piglet

T181 Screening based on antibacterial and phytase activities of lactic acid bacteria towards their use as a chicken probiotic supplement. H. R. Taheri*¹, H. Moravej¹, F. Tabandeh², M. Zaghari¹, and M. Shivazad¹, ¹*University of Tehran, Karaj, Tehran, Iran,* ²*National Institute of Genetic Engineering and Biotechnology, Tehran, Iran.*

The objective of this research was to screen the lactic acid bacteria of the chicken digestive tract to identify a strain as a source of probiotic. This selection was carried out to find a strain with high antibacterial and phytase activities. A total of 62 strains of lactic acid bacteria of broiler origin were investigated for their use as a probiotic feed supplement. In vitro studies included antibacterial and phytase activities. Antibacterial activities were examined against *Salmonella enteritidis*, *Salmonella typhimurium* and *Escherichia coli* O78:K80 by well diffusion assay, and the medium culture that contained calcium phytate was used for measuring the halo zone of phytase activity. Additionally, aggregation, co-aggregation, amylase, lipase and protease activities, cell surface hydrophobicity, growth with bile salts (ox gall) and tolerance to acidic pH of this strain were tested. Among all the isolates, strain LT171 was selected for high antibacterial and phytase activities. Also this strain had aggregation (90 min), amylase and protease activities, cell surface hydrophobicity (85%), and resistance to pH 3 and bile salts (0.075% in medium culture). This strain didn't show any co-aggregation, and lipase activity. This research showed that there is a strain with high antibacterial and phytase activities as a source of a chicken probiotic. Previous studies have not selected the final strain based on these characteristics. This strain could potentially be used as a feed additive.

Key Words: phytase activity, antibacterial activity, probiotic

T182 Effects of different pen types and dietary antibiotics on growth performance, immune response and diarrhea occurrence of weanling pigs. Y. S. Noh*, K. W. Kang, Y. H. Choi, S. K. Jang, Y. D. Jang, H. K. Oh, and Y. Y. Kim, *Seoul National University, Seoul, Korea.*

The objective of this experiment was to evaluate the effect of different pen types and dietary antibiotics on the growth performance, immune response and diarrhea occurrence of weanling pigs. The treatments were assigned according to a 2x2 factorial arrangement. The first factor was 2 levels of added dietary antibiotics (0 and 0.10%) and the second factor was different pen types (elevated pen and floor-slotted pens). Avilamycin was supplemented in antibiotic treatment diets. For the feeding trial, a total of 192 piglets, 24 \pm 2 d of age with initial body weight 7.90 \pm 0.25kg, were allotted to treatments by body weight and gender in a RCB design with 6 replicates and 8 pigs per pen. Until 3 weeks, floor-slotted pen treatments showed higher body weight ($P < 0.05$, 10.32 vs. 11.18kg) and ADFI ($P < 0.01$, 288 vs. 350g) than the elevated pen treatments. However, after 3 weeks, the elevated pen treatments showed significantly higher body weight, ADG ($P < 0.01$, 610 vs. 510g) and ADFI ($P < 0.01$, 938 vs. 807g) than the floor-slotted treatments. During the whole experimental period (0 to 5 weeks), ADFI was higher

in the elevated pen treatment compared to the floor-slotted pen treatment ($P < 0.01$, 696 vs. 643g in ADFI). However, no differences were found in ADG and G:F ratio among all treatments. At 3 weeks the elevated pen treatments showed a lower diarrhea occurrence score ($P < 0.05$, 3.2 vs. 3.7) compared to the floor-slotted pen treatment. The dietary antibiotics did not influence diarrhea score. Floor-slotted pen treatments at Wk 2 were significantly higher in serum IgG concentration ($P < 0.01$, 0.9 vs. 2.0mg/ml). These results demonstrated that elevated pens were better than floor-slotted pens for improving growth performance and immune responses in weanling pigs.

Key Words: pen type, weaning pig, growth performance

T183 Evaluation of antimicrobial activity of organic acids against *Salmonella typhimurium* isolated from swine. M. R. Messina^{*1}, E. Grilli¹, S. Albonetti², and A. Piva¹, ¹DIMORFIPA, University of Bologna, Italy, ²DSPVPA, University of Bologna, Italy.

Aim of the study was to investigate the antibacterial activity of organic acids against the serovar *typhimurium* of *Salmonella enterica* subsp *enterica* isolated from pig slurry. Organic acids (OA) tested were: citric, sorbic, malic, fumaric, benzoic, lactic, heptanoic and octanoic. A broth dilution assay was performed as follows: 96-wells microtiter plates were filled with 10^4 CFU of *Salmonella*/well and with each OA solutions at concentrations from 0.49 mM to 500 mM. The positive control wells were inoculated in the same way without the addition of any substance. Medium was buffered at pH 6.5 and plates were incubated at 37 °C. The turbidity of cultures after 24 hours was used as indicator of bacterial growth and evaluated by absorbance measurement at 630 nm. Optical density (OD) data were analyzed by ANOVA followed by a Dunnett post-test; Pearson correlation, and linear regression between the OD data and OA concentrations were also exploited. Compared to control, benzoic acid at 125 mM completely inhibited *Salmonella* growth ($P < 0.01$), while other acids were effective at much lower concentrations in reducing the OD of *Salmonella* by -85% heptanoic acid and by -83% octanoic acid at 1.82 mM, by -92% sorbic acid at 50 mM ($P < 0.01$); citric and malic acids reduced OD by -51% and -85% at 250 mM and 500 mM, respectively ($P < 0.01$). Fumaric and lactic acids did

not significantly inhibit *Salmonella*. Linear regression analysis showed an interesting dose-effect for citric, malic, heptanoic and octanoic acid ($R^2=0.99$; $R^2=0.98$; $R^2=0.94$; $R^2=0.91$, respectively, $P < 0.01$). The interaction and possible synergistic effect of these acids should be tested to improve their efficacy. Heptanoic, octanoic, sorbic, citric, malic, and benzoic acids showed strong antibacterial properties, and therefore could be regarded as useful instruments both as food preservatives as well as feed additives in animal nutrition against *Salmonella*.

Key Words: swine, *Salmonella*, organic acids

T184 Effect of Natuzyme supplementation on broiler performance in deficient standardized ileal threonine diets. S. Khalaji, M. Zaghari*, and M. Shivazad, University of Tehran, Karaj, Iran.

The objective of this study was to determine the effects of Natuzyme supplementation on broiler performance in a threonine deficient diet. Day-old male broiler chicks were randomly assigned to 20 battery cage pens in a completely randomized block design and grown to 6 wk of age. Birds were fed dietary treatments from 1 to 42 d of age. The 6 treatments were basal diets containing 0.56 and 0.46% standardized ileal threonine (SID Thr) in starter and grower periods, respectively. Treatments 2 to 6 were the basal diets supplemented with 0.1, 0.2, 0.3, 0.4 and 0.5 g/kg Natuzyme. Body weight and feed intake of birds were recorded at 28 and 42 d of age. In vivo lymphoproliferation of birds against Phytohemagglutinin-P (PHA-P) was measured at 36 d of age. Data was analyzed using the GLM procedure of SAS. Means were compared by Duncan's multiple range test. Supplementing diets with Natuzyme significantly ($P < 0.001$) improved feed conversion ratio (FCR) at 28 and 42 d of age. The effect of Natuzyme on body weight was significant ($P < 0.05$) at 28 d of age but it had no effect on body weight at 42 d of age. In vivo lymphoproliferation against the Phytohemagglutinin-P (PHA-P) at 36 d of age significantly ($P < 0.05$) increased with supplementation of Natuzyme. There were no significant differences in breast, thigh and abdominal fat at 42 d of age. These results showed that Natuzyme improved the efficiency of broilers fed a low threonine diet during the starter period.

Key Words: Natuzyme, threonine, broiler performance

Nonruminant Nutrition: Nutrients

T185 Effects of protein and sulfur AA concentration in diets fed to weanling pigs on growth performance and diarrhea incidence. T. C. S. Reis^{*1}, G. Mariscal-Landin², P. E. Urriola³, and H. H. Stein³, ¹Universidad Autonoma de Queretaro, Queretaro, Mexico, ²INIFAB CENID Fisiologica, Queretaro, Mexico, ³University of Illinois, Urbana.

A 3-wk experiment was conducted to measure the effect of dietary CP, Met, and Cys levels on pig growth performance, and incidence (ID) and severity of diarrhea (SD) during the post-weaning period. Sixty pigs were weaned at 23.9 ± 3.6 d of age (initial BW: 7.48 ± 0.50 kg) and allotted to 4 treatment groups based on sex, litter of origin, and BW. There were 3 pigs per pen and 5 pens per treatment. Four antibiotic-free diets were formulated. The HCP diet contained 23.58% CP, 0.34% Met, and 0.33% Cys. The LCP diet contained 17.64% CP, 0.25% Met, and 0.26% Cys. The HMet diet contained 16.95% CP, 0.32% Met, and 0.24% Cys. The HCys diet contained 17.68% CP, 0.26% Met, and 0.49% Cys. The ID was the number of days where diarrhea was observed within a pen. The SD was based on a daily visual fecal consistency score on a scale of 0 to 3. Results showed that for the entire 21-d period, no differences

in ADG or ADFI were observed among treatments. However, G:F were greater ($P < 0.01$) for pigs fed the HCP diet (0.656 kg/kg) than for pigs fed the LCP (0.501 kg/kg), the HMet diet (0.495 kg/kg), or the HCys diet (0.479 kg/kg). The ID in wk 1 was greater ($P < 0.01$) in pigs fed the HCP diet (4.6 d) than in pigs fed the other diets (2.0, 2.0 and 2.0 d, for LCP, HMet, and HCys diets, respectively). In week 2 and 3, no differences among diets were observed for ID. Pigs fed the HCys diet had lower ($P < 0.05$) ID (6.4 d) over the entire period than pigs fed the HCP diet (15.2d). The SD was greater ($P < 0.01$) in pigs fed the HCP diet during wk 1 than for pigs fed LCP, HMet, and HCys diets (0.94, vs. 0.34, 0.37, and 0.32, respectively). In wk 2, no differences in SD among treatments were observed, but pigs fed the HCys diet had the lowest ($P < 0.05$) SD in wk 3 (0.31) and over the entire period (0.33) compared with pigs fed the HCP, the LCP, and the HMet diets (1.17, 0.57, 0.66, and 1.04, 0.53, 0.55, respectively). In conclusion, pigs fed a HCP diet gained weight more efficiently, but had also greater incidence and severity of post-weaning diarrhea than pigs fed LCP, HMet, or HFCys diets. High levels of Cys in the diet reduce post-weaning ID and SD.

Key Words: pigs, diarrhea, dietary CP