1968 Pelleting stability of Ronozyme™ P CT phytase in commercial feedmills. N.E. Ward* and J.W. Wilson, *Roche Vitamins Inc.*.

Ronozyme P™ CT (RCT), a phytase, was developed for improved heat stability for pelleted feeds to avoid the need for liquid phytase application. The patented, thin lipid coating of the beadlet reduces enzyme exposure to moisture, one of the two major destabilizing factors for phytase during pelleting. Retention tests were completed in 12 randomly chosen integrated U.S. poultry commercial feedmills. In each case, a total of 0.4 to 0.6 lbs (181 to 272 grams; no carrier) was added per 2000 lbs (907 kg) of feed. A total of 10-20 samples of mash feed were taken as the feed exited the mixer, while 10-20 samples of pelleted feed were obtained at the cooler. Samples were taken at equal-time intervals based on feed flow rate. The percent RCT phytase remaining was 68 to 90% across pellet temperatures of 163°F to 210°F (73°C to 99°C). RCT retention tended to plateau at 70-80%, even at the highest temperatures tested. The mean mixing coefficient of variation (%CV) for phytase was 14.2% in mash, but 12.6% in pelleted feed, an improvement of about 11% in %CV. Mixing during augering and cooling likely accounts for the improved %CV in pelleted feed. RCT phytase retention is no less than about 70% across typical pelleting temperatures, thus serves as a viable, economically attractive alternative to liquid phytase in pelleted feeds. Conditioned mash was 16-17% moisture across mills, and may be the factor that limits RCT phytase destruction at the higher temperatures.

Feedmill #	1	2	3	4	5	6	7	8	9	10	11
Pellet temp., °C	73	80	81	82	89	89	90	91	93	97	99
Pellet temp., °F	163	176	177	180	193	193	194	195	200	207	210
Condition time, sec	20	30	20	35	20	20	25	20	25	20	20
Retention, %	90	82	82	70	72	75	78	80	68	80	75

Retention is percent phytase remaining in pellets relative to starting level in mash; CV = Coefficient of variation

Key Words: Ronozyme P™ CT, Phytase heat stability, Feedmills

1969 Comparison of Ronozyme P™ CT, Ronozyme P™ Liquid and Natuphos® Liquid in a commercial broiler pelleted feed. N.E. Ward*[1], J.W. Wilson[1], and J. McNaughton[2], [1]*Roche Vitamins Inc., Parsippany NJ,* [2]*Solutions BioSciences Inc., Salisbury MD.*

Ronozyme P™ CT (RCT), Ronozyme P™ Liquid (RL) and Natuphos® Liquid (NL) were compared in a male broiler floorpen study with feed pelleted at 210°F(99°C)/20 sec by a commercial broiler feedmill. Eight (8) treatments were fed, including positive (POS) and negative (NEG) controls. Final targeted "feed trough" phytase levels were as noted. RCT: 500, 750, 1000 FYT/kg; RL: 500, 750 FYT/kg; NL: 500 FTU/kg. Eight (8) reps/trt were fed for 21 days in floorpens with 50 birds/pen. The feed was a basic commercial corn/SBM diet. Earlier observations indicated a 72-75% retention of RCT when pelleted at 210°F(99°C)/20 sec conditioning, thus RCT was added to the NEG mash at a rate to compensate for expected retention due to pelleting. Liquid phytases were sprayed onto pelleted NEG feed. The right tibia was ashed from 10 birds/pen on day 21.

Total P analysis was 0.57% for NEG and 0.72% for POS control. Average phytase retention across RCT diets was 76%, thus met targeted values. In addition, phytase analysis confirmed targeted values for liquid phytase addition. Body weights were generally improved (P<.05) over NEG with phytase addition. F/G and bone ash improved (P<0.05) with increased phytase levels, but no difference in F/G existed across phytase sources at 500 units/kg. RCT and NL at 500 units/kg were equivalent across all variables tested, whereas bone ash for RL (500 FYT/kg) was higher (P<.05) than that for NL at 500 units/kg. These results find that RCT can be added to feed prior to pelleting, and retain sufficient quantities to support bird performance that is equivalent to liquid phytases of similar units/kg, and applied post-pelleting.

Trt	Final phytase, units/kg	Total P, %	Body wt., g	F/G	Mortality, %	Bone ash, % DM
POS	68	0.72	692abc	1.379e	1.0ab	38.95c
NEG	21	0.57	677c	1.403f	1.7ab	37.34d
RCT	433	0.55	690bc	1.357bcd	1.5ab	39.03c
RCT	815	0.55	703ab	1.343bc	0.8ab	41.51ab
RCT	1022	0.53	710ab	1.321a	1.5ab	42.7a
RL	527	0.55	702ab	1.364de	2.1b	41.06b
RL	829	0.55	702ab	1.337ab	0.4a	42.2ab
NL	422	0.55	680bc	1.358cd	0.8ab	39.27c

POS = Positive control; NEG = negative control; RCT = Ronozyme P™ CT; RL = Ronozyme P™ Liquid; NL = Natuphos Liquid

Key Words: Phytase, Ronozyme P™ CT and Liquid, Broilers

1970 Comparison of a solid-state fermentation produced phytase with a traditional liquid-fermented phytase in broiler chicks. J Pierce*[1], J Driver[2], and J Harter-Dennis[3], [1]*Alltech, Nicholasville, KY,* [2]*University of Pretoria, South Africa,* [3]*University of Maryland Eastern Shore, Princess Anne.*

Enzyme preparations produced in solid-state fermentation contain measurable amounts of protease, xylanase, and cellulase, in addition to phytase. An experiment was conducted to compare the efficacy of phytase produced by solid state fermentation (**SSF**) with a phytase produced by liquid fermentation (**LF**) containing no measurable enzymatic side activities. One hundred seventy-five 4-d old broiler chicks were used in a randomized block design with 5 dietary treatments and 5 replications of 7 birds/cage for 14 d. Dietary treatments 1-3 contained 0.25, 0.30 or 0.35% available P (**aP**), respectively. Diets 4 and 5 contained 0.25% aP + SSF or LF phytase (300 PU/kg). All diets were formulated to meet or exceed NRC requirements for all nutrients except P. The corn-soybean meal based mash diets contained 1.0% Ca, 1.26% lys, .97% TSAA, and 3200 kcal ME/kg. Total gain for the five treatments was 336, 363, 365, 362, 352g and gain:feed was 0.70, 0.69, 0.67, 0.69, 0.68. Both forms of phytase improved gain over the control ($P = 0.06$). Tibia ash percentages were 42.7, 46.3, 49.5, 48.2, and 48.1 for treatments 1-5, respectively. In addition, there was a linear improvement in tibia ash percent as P was increased ($P < 0.01$). Similar responses in bone traits were found in tibia strength and toe ash. Based on regression of Treatments 1-3 on tibia ash, it was found that 300 PU/kg of phytase is equivalent to 0.11% of dietary P. The SSF phytase was more effective at reducing fecal P than LF phytase (29 vs 20%, $P = .05$). The results of this experiment indicate that phytase produced by SSF may have advantages over LF phytase in terms of animal performance and P excretion.

Key Words: Chicken, Phytase, Phosphorus

1971 Efficacy of Allzyme Phytase® produced by solid-state fermentation in improving the phosphorus availability of wheat-soybean meal diets for broilers. Y.B. Wu[1], V Ravindran[1], D.T. Thomas[1], B.J. Camden[1], P.C.H. Morel[1], W.H. Hendriks[1], and J. Pierce*[2], [1]*Massey University, Palmerston North, New Zealand,* [2]*Alltech, Nicholasville, KY.*

Allzyme Phytase® is an enzyme complex produced by solid-state fermentation, which contains several side-enzyme activities in addition to phytase. The influence of this phytase product on the performance and toe ash contents of male and female broilers fed a wheat-soybean meal diet was investigated in a 6-wk trial. Dietary treatments were: 1) negative control (0.30 and 0.20% nonphytate P during wks 1-3 and 4-6, respectively), 2-4) treatment 1 + 0.06, 0.12, or 0.18% nonphytate P as monocalcium phosphate, and 5-8) treatment 1 + 500, 1000, 1500, or 2000 PU/kg phytase as powder. A 1.4:1 Ca:P ratio was maintained. Diets were cold pelleted (65C) and, within sex, each diet was fed to 5 pens of 8 birds each. In both sexes, weight gains ($P < 0.05$ to 0.001), gain/feed ($P < 0.05$ to 0.001) and toe ash contents ($P < 0.001$) were increased as the P or phytase was added to the low-P diet. The magnitude of increment in all parameters was greatest for the first addition

of P or phytase and then tended to plateau with further additions. Toe ash contents of birds fed the low-P diet with 500 PU phytase/ kg of diet were comparable to those of birds fed adequate-P diets. Unexpectedly, the birds receiving the low-P diet plus 1000 PU phytase/kg had a similar weight gain and better ($P < .05$) feed efficiency compared to those receiving P-adequate diets. Equations based on performance responses to graded additions of supplemental nonphytate P and phytase estimated the P equivalency of 1000 PU Allzyme® phytase/kg of diet to exceed 0.22%. These equivalency values may reflect enzyme activity above that accounted for by phytase activity alone. Thus, the secondary enzymes may have played a part in improving the availability of nutrients from wheat other than P alone.

Key Words: Phytase, Phosphorus, Wheat

1972 Effect of phytase on reduced available phosphorous levels in broiler diets. S. Parhizcar*, A. Kamyab, M. Shivazad, and R. Ashtiani, *University of Tehran, Animal Science Dept.*.

A study was conducted to determine the effects of a commercially produced phytase enzyme on feed intake, body weight gain, feed conversion, toe ash, mortality, leg abnormality and blood calcium (Ca) and phosphorous (P) of broilers. This experiment was conducted in a completely randomized design. All of the five diets were isocaloric and isonitrogeneous, consisting of five replicates, in which 25 mixed sex day old birds were housed. The experimental diets consisted of: A) basal control diet, B) control diet, but consisting of 85% recommended available phosphorous level plus phytase, C) control diet, but consisting of 85% of the recommended available phosphorous level without phytase, D) control diet, but consisting of 65% of the recommended available phosphorous level plus phytase, and E) control diet, but consisting of 65% of the recommended available phosphorous level without phytase addition. At the end of study, diet D resulted in heavier weight gain and better feed conversion which was statistically significant ($P<0.05$). At the same age, diet B resulted in higher toe ash and phosphorus serum ($P<0.05$). Likewise, birds which received diet C had significantly ($P<0.05$) higher Ca level in their blood. No statistically significant differences were found between carcass quality, mortality and leg abnormalities in the dietary treatments ($P>0.05$).

Key Words: Phytase, Broiler, Toe ash

1973 Effects of microbial phytase on apparent ileal digestibility of amino acids in broiler chicks fed a corn-soybean meal diet formulated on an ideal protein basis. D. R. Ledoux*, J. N. Broomhead, and J. D. Firman, *University of Missouri Columbia, MO USA*.

A 21-day battery study using 400 day-old male broiler chicks was conducted to determine the effects of microbial phytase on apparent ileal digestibility of nitrogen and amino acids and on apparent metabolizable energy (AME). The 2 X 4 factorial arrangement of treatments included a 100% ideal protein (IP) diet (20% CP) and a 90% IP diet, supplemented with four levels of microbial phytase (0, 250, 500, or 1000 FTU/kg diet) supplied by Natuphos®. Ten replicate pens of five chicks were assigned to each dietary treatment. There was no effect ($P > 0.05$) of phytase or IP on feed intake or body weight gain. There was also no effect ($P > 0.05$) of phytase on feed conversion, AME, or nitrogen digestibility. However, chicks fed the 90% IP diet were less efficient ($P < 0.05$) in converting feed to gain, but digested more ($P < 0.05$) nitrogen and utilized more energy (AME) compared with chicks fed the 100% IP diet. Significant ($P < 0.05$) phytase by IP interactions were observed for the dietary essential amino acids threonine, valine, methionine, isoleucine, leucine, phenylalanine, and histidine. Significant ($P < 0.05$) phytase by IP interactions were also observed for the dietary nonessential amino acids aspartic acid, serine, proline, glycine, alanine and cystine. The interactions indicated a benefit for supplementing diets with phytase in chicks fed 90% IP but no benefit for supplementing diets with phytase in chicks fed 100% IP. In addition to the phytase by IP interactions, there was a significant ($P < 0.05$) IP main effect observed for all of the dietary essential amino acids (except for methionine), and most of the dietary nonessential amino acids (exceptions serine and glutamic acid), with chicks consuming the 90% IP having higher digestibilities compared with those consuming the 100% IP diet. Phytase supplementation of a 90% IP diet was effective in increasing apparent ileal digestibility of several amino acids.

Key Words: Chicks, Phytase, Amino acid digestibility

1974 The effect of a non-GMO phytase on the performance of broilers fed diets containing different concentrations of phosphorus. Ruedi Hadorn[1], Hans Wiedmer[1], Samuel Nydegger[2], and Peter Spring*[2], [1]*Swiss Poultry Husbandry School, Zollikofen, Switzerland,* [2]*Swiss College for Agriculture, Zollikofen, Switzerland*.

The aim of the present study was to determine the effect of a non-GMO phytase on performance of broilers fed diets containing different concentrations of phosphorus. The trial was conducted as a 2x2 factorial design with phytase (E) (0 vs. 1 kg/t) and available phosphorus concentrations (2.65 vs. 3.65 g/kg) as experimental factors. The trial included 4,500 chicks (Ross PM3). Birds were assigned to 20 pens (225 birds per pen) with 16-m^2 surface each. The sex ratio was 1 to 1 in each pen. Broilers were housed on litter. All animals received the same pre-starter diet for nine days. They received grower diets (13.2 MJ UE, 20.7% CP) from day 10 through 35 and the finisher diet from day 36 through 41 *ad libitum*. The following parameters were determined: Life weight, feed intake, feed conversion, mortality (d10, 21, 35, 41) as well as litter quality, carcass grade and bone breaking strength at day 41. Effects of experimental factors as well as interactions were analyzed by ANOVA. In addition, mean values were compared with the test of Bonferroni ($p<0.05$). Overall average daily feed intake was increased by phytase addition (90.8 g vs. 93.5 g; $P<0.05$). The increase in feed intake led to a significant increase in life weight (d41) (2118 vs. 2197g) when phytase was included in the diets. Mean feed conversion was 1.79 and was not affected by treatment. Average mortality over the entire trial period was generally low (1.5%) and not affected by treatment. The production index was significantly higher (279 vs. 290) with the addition of phytase, due to improved weight gain and feed intake. The reduction in dietary phosphorus levels from 3.65 to 2.65 g/kg had no significant effect on animal performance at day 41. There was no statistical difference in litter quality and group uniformity between treatments. Phytase addition tended to improve carcass yield (65.2 vs. 66.0%). Tibia breaking strength (measured as kg/bone) was numerically affected by treatment: high P: - E (44.82 kg) +E (47.30 kg); low P -E (43.27 kg) +E(45.68 kg), however, differences were not significant. This data indicate that non-GMO phytase has the potential to significantly improve animal performance.

Key Words: Phytase, Non-GMO, Broiler

1975 Evaluation of a high coefficient of variation (CV) of phytase consumption on the performance of broilers from 21-42 days of age. J. M. Harter-Dennis*[1], J. Timmons[1], and A. E. Sefton[2], [1]*University of Maryland Eastern Shore, Princess Anne, MD,* [2]*Alltech, Inc., Guelph, Canada*.

A trial was conducted to determine the effects of a high coefficient of variation (CV) of phytase consumption on the performance of commercial broilers during the 21-42 day of age finisher phase. All birds were fed a commercial starter ration from 0-21 days of age that met or exceeded NRC requirements for all nutrients. On day-21 birds were allotted in a RCB design to 4 treatments with 6 reps/treatment and 5 male broilers/rep. Treatments consisted of T1:basal diet (B) containing 3200 kcal/kg ME, 20%CP, 0.9% Ca and 0.15% available phosphorus (AP), T2:B + the recommended level of phytase (11,500 PTU/kg ALLZYME®, Alltech, Inc) daily, T3:B + 2X the recommended phytase level (23,000 PTU/kg) every-other-day and B on alternate days and T4: B + .20% AP. The CV of phytase consumption of T2 was 0% and that of T3 was 103%. The diets were adequate in all other nutrients. The addition of phytase (T2 and T3) sig. improved tibia bone breaking strength (BBS) and % tibia ash (TA) when compared to the phosphorus deficient diet (T1). Birds fed the AP adequate diet (T4) had tibia BBS and % TA values sig. higher than those fed T1, T2 and T3. There were no significant differences in these parameters due to the %CV of phytase consumption (T2 vs T3). These results confirm that phytase increases dietary phosphorus availability and suggests that older birds from 21-42 days of age may tolerate the high CV's of phytase application often experienced with post-pellet spray systems. These results also confirm similar findings with starter broilers from 0-21 days of age.

Treatment	Gain(g)	G/F	BBS(kg)	%TA
T1	829 ^{b}	.353	24.2 ^{c}	45.5 ^{c}
T2	899^{ab}	.393	32.2 ^{b}	49.2 ^{b}
T3	942^{ab}	.411	31.6 ^{b}	48.6 ^{b}
T4	1027^{a}	.417	40.5^{a}	53.5^{a}
ANOVA	P≤.05	NS	P≤.01	P≤.01

Key Words: Phytase, Broilers, Phosphorus

1976 Influence of Allzyme (Phytase) supplementation on Bovans hens. H. Anwar Ahmad*[1], S. S. Yadalam[2], and David A Roland, Sr.[2], [1] *Tuskegee University,* [2] *Auburn University.*

A 2x3 factorial experiment to determine the efficacy of supplemental phytase was conducted using 960 40 wks old Bovan hens. Experimental diets were formulated based on two lysine levels, 0.83 and 0.92%. Within each lysine level, a positive control diet containing 0.4% available Phosphorus, a negative control Phosphorus deficient diet containing 0.1 % available Phosphorus and the negative control diet supplemented with 11,400 PTU/kg Phytase (Allzyme) were formulated. Performance criteria evaluated were egg production, egg weights, egg specific gravity, and feed consumption. Reducing the lysine level from 0.92 to 0.83 % significantly reduced the egg weight and feed consumption but did not drop egg production. Reducing the available Phosphorus level from 0.4 to 0.1% reduced the egg production, egg weight, and feed consumption. Supplying 11,400 PTU/kg phytase (Allzyme) to the negative control Phosphorus deficient diets (0.1%) significantly improved the egg production, egg weight, and feed consumption comparable to those of positive control diets that contained 0.4% available Phosphorus. Feed efficiency of phytase supplemented negative control diets (0.1%) was even better than the positive control diet of 0.4% available Phosphorus. Phytase (Allzyme) supplementation reversed the adverse effects of Phosphorus deficiency and further improved the feed efficiency.

Key Words: Allzyme, Bovans hens, Performance criteria

1977 Effects of dietary supplemental microbial phytase and nonphytate phosphorus on performance, nutrient digestibility and egg quality of laying hens. S. H. Kim*[1], W. J. Lee[2], S. J. Lee[1], D. J. Yu[1], S. Y. Park[3], B.S. Kang[1], J. C. Na[1], and K. S. Ryu[3], [1] *National Livestock Research Institute of Rural Development Administration, Daejeon,* [2] *Daesung Microbiology Co., LTD,* [3] *Department of Animal Resources and Biotechnology, Chonbuk National University.*

A total of six hundred forty Hyline brown laying hens were assigned into sixteen treatments to investigate the effect of dietary supplemental microbial phytase and non-phytate phosphorus (NPP)on nutrient digestibility and performance of laying hens. Phytase(Transpos^{R}) was supplemented at 0, 300, 500 or 1,000 DPU/kg diet. NPP levels were adjusted with tricalcium phosphate(TCP) to be 0 (0.11% NPP), 0.5% (0.20% NPP), 1.0% (0.29% NPP) and 1.5% (0.38% NPP) of diets. Dietary ME, CP and Ca were maintained at 2,800 kcal/kg, 16% and 3.5%, respectively. Egg production, egg weight, feed intake, feed conversion (FC), egg qualities and nutrient digestibility were measured from 21 to 32 weeks of age (WOA). Egg production of birds fed phytase was significantly increased compared to that of non supplemental phytase groups (P<0.05). TCP supplements also significantly improved egg production and daily egg mass up to 0.5% (P<0.05). Egg weight was not different between treatment groups. Feed intake was not statistically different among phytase supplemental groups, however, it was significantly increased with TCP supplementation (P<0.05. FC was significantly improved with phytase supplements (P<0.05), but was not different from FC of those fed TCP supplements. All nutrient digestibilities tended to improve with phytase and TCP supplement, but was not different at various phytase supplementation. The effect of phytase supplement was greater in low phosphorus diets compared to that of NRC recommended levels. Eggshell breaking strength and thickness also improved significantly in phytase supplemental groups (P<0.05). Tibial ash and P content were slightly increased with phytase supplements. However, Ca content was significantly higher in phytase supplemental groups than without phytase groups (P<0.05. As a result, dietary supplemental phytase decreased the level of NPP supplementation necessary. The optimum Transpos^{R} of diets were estimated to be approximately 300 DPU/kg diets. The results of this laying hen experiment showed that phytase supplementation improved performance, nutrient digestibility and bone development of birds fed low phosphorus diets.

Key Words: Microbial phytase, TCP, Laying hens

1978 The response of laying hens to phytase added to corn-soybean meal-based diets containing two levels of available phosphorus. 2. Phytate phosphorus utilization. M.A Kamberi[1], H.M. Edwards[2], G.M. Pesti*[2], S. Muratovic[3], S. Muji[1], and R.I. Bakalli[2], [1] *University of Prishtina, Prishtina, Kosova,* [2] *The University of Georgia, Athens, GA 30602-2772,* [3] *University of Sarajevo, Sarajevo, Bosnia and Herzegovina.*

A trial was conducted to determine the effects of adding phytase (Natuphos®, BASF) to corn-soybean laying hen diets for 8 weeks with different available phosphorus (AP) levels. After a 14-d adjustment on a common layer diet, 144 Hysex Brown hens were allotted using a randomized complete block design, to four treatments in a factorial arrangement of two AP levels (0.12 or 0.42%) and two phytase levels (0 or 600 FTU/kg). Each treatment was assigned to 3 replicates of 12 hens. Body weight, feed consumption, egg weight, egg specific gravity, and egg shell weights were measured biweekly. Egg production was recorded daily. Total excreta were collected each day and approximately 10% were dried in a forced draft oven. Excreta were pooled by 2-week periods for phytate phosphorus analysis. As reported earlier, the performance of hens fed 0.12% AP + phytase and 0.44% AP without phytase were very similar for egg production (96±2 vs 93±3%), egg weight (63±1 vs 63±1 g), egg shell weight (6.3±0.1 vs 6.4±0.1 g) and feed intake (106±1 vs 105±4 g). Hens fed the diets containing 0.12 and 0.44% AP utilized only 10.6±1.86 and 7.95±0.38% of the phytate phosphorus fed, respectively. When 600 FTU phytase per kg was added to the diets, phytate phosphorus utilization increased to 41.02±1.11 and 33.45±2.95%, respectively. Both the level of AP (P=0.024) and phytase (P<.0001) significantly affected phytate phosphorus utilization (their interaction was not significant, P=0.219). It is concluded that corn and soybean meal diets contain 0.18 to 0.22% phytate phosphorus that can be made partially available by adding phytase to the diet.

Key Words: Available phosphorus, Laying hens, Egg production

1979 Effects of Roche Ronozyme CT on Hy-Line W-98 laying hen performance when fed low phosphorus diets. S. E. Scheideler*[1], N. Ward[2], and M. Jalal[1], [1] *University of Nebraska,* [2] *Roche Vitamins.*

A 4 X 3 factorial arrangement of 4 levels of Ronozyme CT (phytase) (0, 350, 450, or 550 IU/kg phytase) and 3 levels of nonphytate phosphorus (NPP) (.10, .20 or .30) were fed to Hy-Line W-98 laying hens from 18 to 35 weeks of age. An additional control diet of .45% NPP was also fed. Each of the 13 diets were assigned to 8 replicate cages with 7 hens per cage (56 hens/diet) in a randomized complete block design. Diets consisted primarily of corn-soybean meal with added fat. Daily egg production (EP) and feed intake (FI) were measured. Egg weight (EW) was measured on one day's production weekly and biweekly, 2 eggs/cage were measured for specific gravity, Haugh units and egg components (yolk, albumen and shell). Tibia ash was measured on tibias from 8 hens/diet at the end of the study. Level of NPP and inclusion of phytase significantly affected EP. EP increased with phytase addition at all 3 low levels of NPP and 350 IU/kg phytase was adequate to increase EP at low NPP levels. Low NPP had a negative effect on feed intake which was reversed by the addition of phytase. Tibia ash significantly increased as NPP increased and as phytase was added to low NPP diets. Increasing level of phytase showed some beneficial effects on increasing tibia ash. Diet treatments had no significant effect on EW, but did have a slight effect on albumen content. Increasing NPP decreased proportion of albumen in the egg and egg albumen quality as measured by Haugh units. Proportion of yolk in the egg increased as phytase was supplemented to low NPP diets. Diet effects on % shell and specific gravity were not significant. In summary, Roche Ronozyme CT phytase supplementation of low NPP diets results in equal or better egg laying performance in the Hy-Line W-98 laying hen to a control .45% NPP diet.

Key Words: Phytase, Laying hen, Phosphorus

1980 The evaluation of Ronozyme™ P CT in layer diets. R.D. Miles[1], N.E. Ward*[2], J.W. Wilson[2], and D. Ledoux[3], [1]*University of Florida, Gainesville FL,* [2]*Roche Vitamins Inc., Parsippany NJ,* [3]*University of Missouri, Columbia MO.*

This study was conducted to evaluate Ronozyme™ P CT (RCT) and Natuphos® G (NG) for phosphorus (P) replacement in layer diets. A total of 455 HyLine W-36 hens (47 weeks of age) were individually housed. Seven treatments were formulated from a corn/SBM basal diet and replicated 13 times (one rep consisted of five individually-housed hens). RCT was fed at 300, 450 and 600 FYT/kg, while NG was fed at 300 FTU/kg diet. Diets 1, 2 and 3 were formulated to contain 0.1, 0.2 and 0.3% available P (AP). All phytase treatments were added to the 0.1% AP diet. Production data were collected over a 12 week period. The right tibia was removed from 20 actively laying hens/trt for ash determination. Phytase analysis was in agreement with formulated values for phytase. No differences (P>.05) existed across trts for hen-day egg production, although the 0.1% AP diet began to experience lower production by week 4. RCT numerically improved egg production for 0.1% AP trt. From week 4, feed intake was lowest (P<.05) for 0.1% AP trt, but was corrected (P<.05) with added phytase. Hens fed either source of phytase in 0.1% AP diets had equivalent bone ash to hens receiving up to 0.3% AP. An in vitro P release determination found no difference (P<.05) between either source of phytase added at 300 units/kg.

Trt	Phytase units/ kg	Egg Prod %	Feed intake g/bird/d	F/G, kg feed/ 12 eggs	Egg wt. g	Bone ash, % dry matter
0.1% AP	–	74.8	86.5^{b}	1.4	62.0	58.9^{c}
0.2% AP	–	79.0	93.4^{a}	1.43	62.4	59.5^{bc}
0.3% AP	–	77.2	93.0^{a}	1.46	62.6	60.5^{abc}
RCT	300	77.7	92.2^{a}	1.43	61.8	60.6^{ab}
RCT	450	77.7	90.7^{ab}	1.41	62.3	59.8^{abc}
RCT	600	78.2	93.2^{a}	1.44	62.8	61.3^{a}
NG	300	74.7	91.7^{ab}	1.49	62.6	60.6^{ab}

AP = Available Phosphorus; RCT = Ronozyme™ P(CT); NG = Natuphos®; abc P<.05

Key Words: Ronozyme™ P (CT), Phytase, Laying hens

1981 Effects of 25-Hydroxyvitamin D_3, vitamin D_3, low phytic acid corn, and phytase on phosphorus utilization by turkey poults fed dietary treatments from hatch to six weeks of age. G. M. Owens and D. R. Ledoux*, *University of Missouri Columbia, MO USA.*

A floor pen study was conducted to compare the efficacy of 25-hydroxyvitamin D_3 (25-OH-D_3) and vitamin D_3 (V-D_3), on phosphorus (P) utilization by turkeys fed wild-type (NC) or low phytic acid corn (LPC), with or without supplemental phytase. A completely randomized design was used with six dietary treatments and five replicate pens of 10 poults allotted to each dietary treatment from day 1 to 42. Dietary treatments included: (A) NC diet containing 0.60% available P (aP) and 1.2% calcium (Ca), supplemented with 3650 ICU vitamin D_3/kg diet; (B) NC diet as in A, but supplemented with 90 mg 25-OH-D_3 (Hy.D®)/ton instead of V-D_3; (C) NC diet containing 0.44% aP, 1.1% Ca, and supplemented with 600 FTU phytase (Natuphos® 600) and 3650 ICU V-D_3/kg diet; (D) NC diet as in C but, supplemented with 90 mg 25-OH-D_3/ton diet instead of V-D_3; (E) LPC diet containing 0.44% aP, 1.1% Ca, 600 FTU phytase and 3650 ICU V-D_3/kg diet; (F) LPC diet as in E, but supplemented with 90 mg 25-OH-D_3/ton diet instead of V-D_3. Compared with turkeys fed diet A, turkeys fed diet B had similar feed intake (FI) and feed conversion (FC; P > 0.05) but lower body weight gain (BWG; P < 0.05). There were no differences (P > 0.05) in FI, BWG, or FC between turkeys fed diet C and diet D or diet E and diet F. There were no differences in percent toe ash (P > 0.05) among dietary treatments. There were also no differences in percent tibia ash or bone breaking strength (P > 0.05) between turkeys fed diets A and B, diets C and D, or diets E and F. There were no differences in litter P (P > 0.05) between turkeys fed diets A and B, diets C and D, or diets E and F. Litter P was reduced (P < 0.05) in turkeys fed diets containing phytase and lower P levels. Results of this study suggest that 25-OH-D_3 may be as effective as V-D_3 in providing the benefits of vitamin D, and that phytase was effective in improving phytate P utilization. Results also indicated that LPC contained more available P than NC.

Key Words: Vitamin D, 25-OH-D_3, Turkeys, Low Phytate Corn

1982 Effect of dietary tea polyphenols or daidzein and copper on cholesterol oxide formation in egg yolk powders. Guang-Hai Qi*, Jing-Dong Yin, Qi-Yu Diao, Jun-Jie Zheng, and Qi-Guang Huo, *Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, China.*

Two trials were carried out to examine the effect of dietary tea polyphenols (TP) or daidzein (DA) and Copper (Cu) on lowering egg cholesterol content and cholesterol oxides formation in heated egg yolk powders. A layer diet based on corn-soybean meal-cottonseed meal was used in both trials. One hundred and twenty, 60-wk-old, Hisex laying hens were allocated to one of the 4 treatments of 30 birds with 5 replicates each in each trial. In trial 1, a 2x2 factorial design of TP (0, 40mg/kg diet) and Cu (4, 125 mg/kg diet) was used. A 2x2 factorial design of DA (0, 10mg/kg diet) and Cu (4, 125 mg/kg diet) was also used in trial 2. Both trials lasted 8 weeks. Three eggs were randomly sampled from each replicate and the egg yolks were separated. The three separated egg yolks from each replicate were combined and put in a microwave oven at medium-high temperature for 3 min to make one heated sample. The results showed that dietary supplementation of TP and DA inhibited the formation of 7-keto-cholesterone and total cholesterol oxides (p<0.01). The interactions between TP or DA and Cu on cholesterol formation were not significant(p>0.05). 7-Keto-cholesterone can be used as a marker in measuring egg yolk oxidation or cholesterol oxides formation because of their convenience of detecting and high correlative to total cholesterol oxides. Dietary supplementation of TP, DA and Cu decreased egg cholesterol and triglyceride content(p<0.05), and increased stability of egg lipids by 16.2%(p<0.05), 12.3%(p>0.05) and 5.7%(p>0.05), respectively. Although the interaction between DA and Cu was not significant (p>0.05), the interaction between TP and Cu was significant on reducing egg yolk cholesterol content(p<0.05). Dietary supplementation of TP, DA and Cu significantly reduced total cholesterol and low-density-lipoprotein cholesterol levels in the plasma(p<0.01). This study indicates that dietary supplementation of TP, DA and Cu could improve the healthy quality of egg yolk.

Key Words: Tea Polyphenols, Daidzein, Cholesterol Oxide

1983 Influence of atorvastatin on select indices of lipid metabolism in normolipidemic and hereditary hyperlipidemic chickens. R. G. Elkin*[1], Y. Zhong[2], S. S. Donkin[2], C. R. Thomas[2], E. Hengstschlager-Ottna[3], and W. J. Schneider[3], [1]*The Pennsylvania State University, University Park, PA,* [2]*Purdue University, West Lafayette, IN,* [3]*Biocenter and University of Vienna, Vienna, Austria.*

We have previously shown that atorvastatin (AT), a potent 3-hydroxy-3-methylglutaryl-coenzyme A reductase (HMGR) inhibitor, is an effective plasma- and egg cholesterol (CHOL)-lowering agent when fed to normolipidemic (NL) laying hens. In the present study, we extended our sample population to include a unique strain of non-egg laying White Leghorn hens with hereditable hyperlipidemia, the so-called restricted ovulator (RO) chickens, and comparatively examined the effect of AT on select indices of lipid metabolism. NL and RO hens, each 82 wk old and sired by a heterozygous RO carrier rooster, were fed a layer ration supplemented (at 0.06 g/100 g diet) with either microcrystalline cellulose or AT. On d 20, 8 NL and 7 RO hens/diet were weighed and blood samples were obtained; the birds were then euthanized and their livers were excised, weighed, and sectioned for subsequent microsome preparation, mRNA extraction, and lipid, crude protein (CP), and moisture analyses. Compared to NL hens, RO birds were heavier, had markedly larger livers, and exhibited greatly elevated baseline plasma total CHOL and triglyceride (TG) concentrations (156 vs. 455 mg/dL and 3,070 vs. 13,837 mg/dL, respectively). AT attenuated plasma total CHOL concentrations in NL and RO hens by 60.3% and 45.1% respectively, and lowered plasma TG levels in these two groups by 71.0% and 34.3%, respectively. Within each genotype, AT reduced liver total CHOL and fat contents, while levels of phospholipids, CP, and moisture were elevated. AT tended to suppress expression of several key genes involved in hepatic very-low density lipoprotein assembly/secretion (apolipoprotein B, microsomal triglyceride transfer protein, and protein disulfide isomerase) while liver HMGR mRNA levels were elevated by AT in both NL and

RO birds, albeit more so in the former group. AT-associated increases in hepatic HMGR immunoreactive protein levels were noted only in NL birds. Down-regulation of HMGR gene expression by higher baseline levels of circulating CHOL may explain why RO birds, compared to NL hens, responded less robustly to AT administration.

Key Words: Atorvastatin, Lipid metabolism, Restricted ovulator

1984 Modification of the lipid profile of eggs yolks by feeding laying hens different sources of fatty acids. Douglas Faria*[1], Monica Mazalli[1], Daniely Salvador[1], Samir Correa[1], and Diogo Ito[1], *Faculdade de Zootecnia e Engenharia de Alimentos, Pirassununga, SP, Brasil*.

Three hundred and ninety Hy-Line W-36 commercial laying hens 46 weeks of age were fed diets containing different fatty acids sources (3% canola oil, 3% sunflower oil, 3% flaxseed oil, 3% fish oil, a mixture of 1.5% flaxseed oil plus 1.5% fish oil and 9% ground flaxseed), two levels of vitamin E (12 and 100 IU/kg) and a control diet in a factorial arrangement with five replicates of six hens each. Performance and internal and external egg quality characteristics were measured. Concentrations of saturated, monounsaturated and polyunsaturated fatty acids, cholesterol, vitamin E and sensory analysis of the eggs were measured. The results showed no influence of the factors studied on the performance, egg internal quality and egg flavor characteristics. Vitamin E concentration in eggs was related to its dietary levels. Eggshell percent and specific gravity were reduced when 100 IU of vitamin E/kg of the diet was fed. Cholesterol content was slightly reduced by inclusion of greater quantities of unsaturated fatty acids in the diet. The lipid profile in the yolk was modified by fatty acids sources. These findings indicate that it is possible to improve the eggs lipid profile, increase vitamin E content, and use flaxseed as a means of increasing the egg linolenic acid (C18:3n-3) content. The inclusion of flaxseed in the diet induced also the production of eggs with higher concentrations of docosahexanoic acid (C22:6n-3).

Key Words: Cholesterol, Fatty acids, Sensory evaluation

1985 Relationship between objective and subjective measurement of egg yolk colour. X. Rincon-Carruyo[1], R. Sala[1], B. Vila[2], J. Galobart*[1], and J. Gasa[1], [1]*Universidad Autonoma de Barcelona,* [2]*Industrial Tecnica Pecuaria S.A. (ITPSA), R&D Dep., Barcelona Spain.*.

An experiment was conducted to evaluate the objective (HunterLab MiniScan Colorimeter; Hunter scale L -lightness-, a -redness- and b -yellowness-, illuminant D65, 10° standard observer) and subjective (Roche Yolk Colour Fan, RYCF) measurement of egg yolk colour, on eggs laid by hens fed 20 different feed treatments obtained as a 4 × 5 factorial design: 4 levels (2.25, 4.50, 6.75 and 9.00 ppm) of natural yellow xanthophylls (CEBSNT, stabilized natural pigment from marigold flowers) and 5 levels (1.125, 2.250, 4.500, 9.000 and 18.000 ppm) of natural red xanthophylls (CFSNT, stabilized natural pigment from paprika). Two-hundred forty Lohmann laying hens, 58 wk old at the beginning of the experiment, were distributed in 40 replicates (6 birds in 2 cages), and 2 replicates were randomly assigned to each treatment. Ten eggs per treatment and day were collected the last 3 days of the 3^{rd} and 4^{th} experimental weeks and evaluated for several quality parameters including egg yolk colour. Performance parameters were also determined for the whole 4-wk experimental period. No significant differences were observed in any parameter but colour measurements of egg yolk. A significant interaction on CEBSNT and CFSNT levels in the diet was observed for all the colour measurements, explained by a significant effect of CEBSNT level at low levels of CFSNT (up to 4.5 ppm), not registered at higher levels. Redness was the best correlated variable with RYCF (r=0.962; n=1034); L and b also showed good negative correlation with RYCF (r=-0.884, and r=-0.876 respectively). The egg yolk colour can be expressed in RYCF units while using the colorimeter for the colour determination, by means of the regression of L a b variables. The equation obtained from this trial (RYCF=5.90+0.396×a-0.205×b+0.051×L; R^2=0.929; n=1034) allows an objective measurement of egg yolk colour, independent of light conditions and observer.

Key Words: Egg Yolk Colour, Natural Pigments, Colorimeter

1986 Comparison of inert markers in poultry digestibility studies. P. R. Ferket*, A. D. Israel, and E. B. Morris, *NC State University, Raleigh, NC USA*.

The use of inert markers added to diets in digestibility studies eliminates the need to estimate the total amount of feed intake and fecal excretion. Analysis of chromium from chromic oxide, the most popular digestibility marker, is tedious, time consuming, and hazardous. The objective of this study was to evaluate the use of two alternative inert markers: titanium dioxide (TiO_2) and acid insoluble ash from Celite^{TM}, a diatomite product (Celite Corp., Lompar, CA). Day-old Nicholas male turkeys were randomly assigned to 45 cages containing groups of 10 poults each and allowed to consume one of 9 experimental diets ad libitum until 17 days of age. The experimental diets consisted of a soybean meal-basal diet containing corn-based positive control diet and 8 test diets containing wheat in place of corn. These 8 wheat-based dietary treatment were a factorial arrangement of 4 wheat sources (A, B, C, and D) and 2 enzyme supplementation levels. Each diet included .5% TiO_2 and .8% Celite^{TM} (w/w). Pooled fecal collections were made 11-14 d were acidified to pH 5.4 with .1N H_2 SO_4 prior to freezing. Diet and excreta were analyzed for Ti and acid insoluble ash contents, respectively, and AME and apparent N retention (ANR) was determined for each dietary treatment using each digestibility marker. Significant wheat source and enzyme main effects were observed on AME and ANR using TiO_2 as the inert marker, but only significant enzyme effects were observed when Celite^{TM} was used. In comparison to the TiO_2 method, the Celite^{TM} method resulted in higher mean ± SE for AME (2217 ± 47 versus 2346 ± 40 kcal/kg, P<.05) and higher mean ± SE for ANR (34.1 ± 1.2 versus 38.2 ± 1.1, P<.05). Although the Celite^{TM} method is less expensive and easier to perform than the TiO_2 method, it requires bigger sample sizes (10 g versus .1 g) and 2 more replicate samples (i.e. 8 versus 10 replicates) to detect equivalent statistical differences in nutrient digestibility.

Key Words: Digestibility, AME, Nitrogen retention

1987 Additivity of amino acid and energy digestibility in barley and canola meal for ducks. D Hong*[1], D Ragland[2], and O Adeola[1], [1]*Department of Animal Sciences,* [2]*Department of Veterinary Clinical Sciences, Purdue University*.

The additivity of amino acid digestibility and metabolizable energy values in barley and canola meal for White Pekin ducks was investigated in an experiment. The difference between the observed value for a complete barley-canola meal diet and the value predicted from measurements determined for individual ingredients was used to test additivity. Six ducks were assigned to each of the following dietary treatments: 1) barley, canola meal, 2) the complete diet and 3) dextrose. Dextrose-fed ducks were used for estimation of endogenous losses for calculation of true amino acid digestibility (TD). Observed values for the apparent amino acid digestibility (AD) and TD in the complete diet were higher than those predicted from individual ingredients. Observed AD for lysine, histidine, tryptophan, alanine and aspartate were higher ($P < 0.05$) than predicted values indicating that digestibilities of these amino acids were not additive. The mean of AD in canola meal (77.29 %) was higher ($P < 0.05$) than the observed values of barley (52.2 %) and the complete diet (64.55 %). For TD values, the differences between observed and predicted were significant ($P < 0.05$) for lysine, histidine and tryptophan. The mean of TD in canola meal, barley and the complete diet were 85.88, 80.87 and 81.33%, respectively. The AME, TME, AMEn and TMEn in barley and canola meal were all additive. Numerically, the respective AME, TME, AMEn, and TMEn values observed in the complete diet were 0.065, 0.083, 0.016 and 0.023 kcal/g higher than predicted values. These differences between observed and predicted values were not significant ($P > 0.05$). The AMEn in barley, canola meal and complete diet were 3.205, 2.764 and 3.042 kcal/g, respectively. The experiment provided new information about amino acid and energy utilization in barley and canola meal for ducks and indicated that AME, TME, AMEn and TMEn in barley and canola meal are all additive in the complete diet but that the digestibility of some amino acids are not additive.

Key Words: Barley, Canola Meal, Energy, Amino Acid, Ducks, Additivity

1988 Utilization of various starch sources as affected by age in the chick. A.B. Batal* and C.M. Parsons, *University of Illinois, Urbana, IL USA.*

Two experiments were conducted to determine if age affects utilization of different carbohydrate sources or high-carbohydrate ingredients fed to New Hampshire x Columbian male chicks. Five pens of eight chicks were fed carbohydrate-soybean meal (SBM) diets (23% CP) containing one of 17 different carbohydrate sources from 0 to 21 days of age. Carbohydrate sources evaluated in Experiment 1 were dextrose, conventional cornstarch, dextrinized cornstarch, corn-syrup solids, pregelatinized unmodified cornstarch, pregelatinized tapioca starch, pregelatinized unmodified waxy corn starch, tapioca dextrin, high amylose starch, and polycose. Carbohydrate sources evaluated in Experiment 2 were conventional corn, waxy corn, high-oil corn, cornflour, riceflour, and dextrose. In Experiment 1, the effects of carbohydrate sources on weight gain at the end of Week 1 were as follows (actual weight gains in parentheses): dextrose (88g), polycose (80g), dextrinized cornstarch (79g), tapioca dextrin (78g), corn-syrup solids (74g), cornstarch (70g), pregelatinized tapioca starch (69g), high amylose starch (60g), pregelatinized unmodified cornstarch (41g), and pregelatinized unmodified waxy corn starch (11g) (pooled SEM = 3.8g). Similar relative results were observed for the 0 to 3 week period except that feeding the corn-syrup solids, pregelatinized unmodified cornstarch and polycose were discontinued after Week 1 due to diet texture problems. In Experiment 2, there were no significant differences ($P > 0.05$) in performance during the first week among chicks fed the various corns and flours; however, chicks fed waxy corn, high-oil corn, or dextrose had numerically higher weight gains. By three weeks of age, chicks fed waxy corn, high-oil corn, or dextrose-SBM diets had significantly ($P < 0.05$) higher growth performance than chicks fed conventional corn, cornflour, or riceflour. These results suggest some potential benefits of feeding dextrose, polycose, dextrinized starches, waxy corn, or high-oil corn during the first 1 to 3 weeks posthatching.

Key Words: Chicks, Starch, Carbohydrates

1989 Dietary protein and thyroid interactions broiler chickens. R. W. Rosebrough, *ARS, Beltsville, MD, USA.*

The thyroid axis is one of the more controversial areas in growth and metabolism of the broiler chicken. Although chemical hypothyroidism decreased growth, artificial changes in thyroid hormone levels did not always change growth predictably. While dietary T_3 and T_4 decreased body weight and feed efficiency of chickens, daily injections of thyroid releasing hormone (TRH) improved growth and increased plasma thyroid hormone concentrations. What is lacking from previous studies is any information concerning recovery from inhibition of T_4 production. Male broiler chickens were fed diets containing 12, 18 or 24% protein 1 mg methimazole/kg diet from 7 to 28 d of age and then a diet containing 180 g protein/kg from 28 to 49 d of age. Birds were killed at 28 and 49 days to 1) determine effects of treatments at 28 d and 2) determine carry over effects of these treatments. In vitro lipogenesis was inversely related to dietary protein levels in control birds at 28 d ($P<0.01$). Dietary methimazole attenuated this effect, resulting in a common rate similar to that attained in the birds fed the highest level of protein without methimazole. In contrast, birds fed methimazole from 7 to 28 d had greater lipogenic ($P<0.01$)rates at 49 d than did their control counterparts. It is unclear at this time if observations noted at 28 d can be traced to reduced feed intake or to changes in thyroid status. Previous pair-feeding studies from this laboratory confirmed that differences in metabolic parameters caused by differences in dietary protein were not attenuated by limit feeding. Observations at 49 d suggest that permutations in the thyroid of the young bird may substantially change metabolism in later life.

Key Words: Thyroid, Metabolism, Lipogenesis

1990 Dietary protein level and stage of development affect expression of the intestinal peptide transporter (cPepT1) in chickens. H. Chen*, Y-X. Pan, E. A. Wong, and K. E. Webb, Jr., *Virginia Tech, Blacksburg, VA, USA.*

The purpose of this study was to evaluate the expression of chicken intestinal peptide transporter (cPepT1) mRNA as influenced by development and dietary protein level. Straight Cobb chicks (317) obtained from a commercial hatchery were used in this study. Ten were sampled at incubation day 18 (E 18). After hatch but before feeding, ten more chicks were sampled (d 0). The rest of the chicks were randomly assigned to one of three floor pens. Diets containing 12, 18, or 24% protein were randomly assigned to be fed to the birds in a pen. Feed intake of the birds fed diets containing 18 or 24% protein were restricted to the intake of birds fed 12% protein. Eleven chicks from each group were sacrificed on d 1, 3, 5, 7, 10, 14, 21, 28, and 35. The duodenum, jejunum, and ileum were removed from each bird and were stored at -80°C until total RNA was extracted and quantified by spectrophotometry. Abundance of cPepT1 mRNA was quantified densitometrically from northern blots that were prepared using our full-length cPepT1 cDNA as the probe. An 18s-rRNA cDNA probe was used as an internal control to evaluate the amount of RNA loaded and transferred. At E 18, expression of cPepT1 mRNA in the small intestine was barely detectable. By the time of hatch (d 0), there was an approximately 50-fold increase in cPepT1 mRNA abundance in all three sections of small intestine. In birds fed the 12% protein, a decrease in cPepT1 mRNA abundance was observed in the three sections of small intestine during d 5 to d 10. Afterwards, cPepT1 mRNA abundance remained low throughout the rest of the feeding period. In contrast, both 18 and 24% protein groups showed an increase in cPepT1 mRNA abundance with time in all three sections of the small intestine. Most of the increase occurred during d 5 to d 10. Our results indicate that expression of cPepT1 mRNA in broilers is regulated by both level of dietary protein and stage of development.

Key Words: mRNA, Dietary protein, Development

1991 The effect of early nutrition and refeeding on satellite cell mitotic activity. P. E. Mozdziak*[1], T. J. Walsh[2], and D. W. McCoy[1], [1]*North Carolina State University,* [2]*Novus International, Inc.*

Myofiber growth is dependent upon the contribution of new nuclei from the mitotically active satellite cell population. The objective of this study was to examine satellite cell mitotic activity, in conjunction with different nutritional paradigms, during the early post-hatch period. Turkey poults were either provided a standard turkey starter diet, the starter diet plus a low fat, high protein hydrated nutritional supplement know as Oasis® Hatchling Supplement (Novus International, Inc. St. Louis, MO), the starter diet plus Solka-flok-dyed green, or no food for the first 3 days post-hatch. A standard starter diet was provided to all birds between 3 and 9 days of age. Bromodeoxyuridine (BrdU) was continuously infused into all groups (n=5 all groups) between hatch and 3 days of age. A second group of identically treated poults was continuously infused with BrdU between 2 and 9 days of age. Mitotically active satellite cells were identified in the *Pectoralis thoracicus* and quantitated using BrdU immunohistochemistry in combination with computer-based image analysis. Satellite cell mitotic activity was significantly higher ($P < 0.05$) in the birds fed a standard starter diet compared to all other treatments at 3 days post-hatch. However, there were no ($P > 0.05$) differences in satellite cell mitotic activity between all treatments at 9 days post-hatch. The *Pectoralis thoracicus* weight, and the *Pectoralis thoracicus* weight to body weight ratio were significantly higher ($P < 0.05$) in the birds fed Oasis® compared to all other treatments at 3 days post-hatch with the fasted birds having the significantly ($P < 0.05$) lowest *Pectoralis thoracicus* weight overall. The larger muscle size observed in the Oasis® treated birds at 3 days post-hatch may result from an increase in the amount of protein per nucleus.

Key Words: Turkey, Oasis® Hatchling Supplement, Skeletal muscle

1992 Incorporation of n-6 and n-3 fatty acids into selected meat portions from male and female broilers fed sardine oil. Rosa Ma. Castillo Domnguez[1], Silvia Carrillo Domnguez*[1], Ernesto Avila Gonzalez[2], Benjamin Fuente Martnez[2], and Fernando Prez-Gil Romo[1], [1]*Instituto Nacional de Ciencias Medicas y Nutricion Salvador Zubiran,* [2]*Fac de Medicina Veterinaria y Zootecnia. Universidad Nacional Autonoma de Mexico.*

The objective of this study was to compare the incorporation of n-6 and n-3 fatty acids (FA) into leg/thigh and breast muscles lipids of male and female poultry fed sardine oil (SO). 432 one-day-old broiler chicks (males and females) were randomly distributed among four treatments: 0%SO, 0.5%SO, 1.5%SO and 3.0%SO. Feed and water were provided ad libitum. At the end of the trial (6 wk), 3 males and 3 females, randomly selected from each treatment, were killed and legs/thighs and breasts were removed. n-6 (LA,AA) and n-3 (ALA,EPA,DHA) fatty

acids of total lipids were determined by gas chromatography. The results showed that birds supplemented with 1.5%SO and 3%SO had significantly ($P<0.05$) higher levels of n-3 (25.27, 50.62 mg/100g) than control group (5.65 mg/100g) into breasts. With regard to leg/thigh the higher incorporations of EPA and DHA were obtained with 1.5%SO (20.68,24.64 mg/100g) and 3%SO (49.17,43.37). The n-6/n-3 ratios obtained in each treatment were: breast 16.4, 4.7, 3.1, 1.8 and for leg/thigh 16.6, 9.6, 5.4, 2.1. There were not changes induced by the sex ($P>0.05$). Under conditions of the present study, it is concluded that SO could be used to increase the EPA and DHA content in tissue lipids of poultry, that there is higher incorporation of FA into leg/thigh than in the breast and, than the sex no affect the deposition of FA in the muscle of the birds.

Key Words: Fatty acids, Sardine oil, Broilers

1993 Changes of magnesium and calcium contents and adenosine triphosphatase activity of shell gland mucosa during eggshell formation in Brown Tsaiya ducks and White Leghorn hens. W. L. Chen and T. F. Shen*, *National Taiwan University, Taipei, Taiwan*.

The changes of magnesium and calcium contents, adenosine triphosphatase (ATPase) activity of shell gland mucosa during various stages of eggshell formation in brown Tsaiya ducks and white Leghorn hens were investigated. Ducks and hens containing an egg in the shell gland were sacrificed at 6, 10, 15, 20 and 22 hours after oviposition, respectively. The whole shell gland lumen was flushed immediately by 50 mL 10 mM Tris-buffer (pH 7.4) for analyzing the amounts of Mg and Ca and their shell gland mucosa were scraped off to determine Mg, Ca contents and ATPase activity. Calcium content in eggshell gland mucosa of both birds decreased to lowest level at 10 hours after oviposition and the data in ducks were lower than hens after active eggshell formation. Total flushed Ca content in uterus lumen of duck or hen were rapidly increased from initial to active stages of eggshell formation. Magnesium content in duck shell gland mucosa was significantly higher ($p<0.05$) than those in hens from 6 to 20 hours after oviposition. Total flushed Mg content in whole shell gland lumen of chicken was higher than duck after 15-hr stage. The specific activities of Ca^{2+}-, Mg^{2+}- or Ca^{2+}-Mg^{2+}-ATPase in shell gland mucosa were only minor changes ($p>0.05$) during eggshell formation in both birds. Mg^{2+} added to incubation medium improved uterus mucosa ATPase activity of Leghorn hens, but not in Tsaiya duck. It was concluded that brown Tsaiya ducks could retain higher Mg and lower Ca contents in shell gland mucosa, and secrete less Mg and more Ca to shell gland lumen for depositing in eggshell. The Mg transport mechanism of shell gland mucosa in brown Tsaiya duck is worthy to be further studied.

Key Words: Shell Gland Mucosa, Magnesium, Adenosine Triphosphatase

ADSA STUDENT AFFILIATE DIVISION

Dairy Foods Undergraduate Paper Presentations

1994 Drinking reduced-fat milk may reduce heart disease risk. C.M. Opsahl*[1], [1]*University of Minnesota-St. Paul*.

Cardiovascular disease (CVD) is the major cause of mortality in the U.S. There are multiple risk factors for CVD including genetics, gender, race, age, tobacco use, exercise, diabetes, obesity, hypercholesterolemia, high blood pressure, elevated triglyceride, and high levels of homocysteine (a by-product of protein metabolism). Recent studies have shown that drinking at least four glasses of reduced-fat milk (<2% fat) may significantly reduce the risk of CVD. The exact mechanism of this relationship is not known but their are several possiblilities. The dietary calcium from milk has been shown to reduce blood pressure in individuals susceptible to hypertension. Milk drinkers tend to be leaner, have higher levels of good or HDL (high-density lipoproteins) cholesterol, and lower incidence rates of diabetes. Finally, dairy products reduce artery-damaging homocystenine. Don't pass up the milk, drink to your health!

Key Words: Cardiovascular disease , Reduced fat milk

1995 Improving calcium availability with dairy foods and inulin. R. L. Blades*[1], [1]*Louisiana State University*.

Osteoporosis affects millions of Americans each year. This disease, resulting from inadequate calcium bioavailabilty, is of particular concern to the elderly but may begin during childhood. Only 30% to 40% of the calcium consumed is absorbed by the body, so new methods must be developed for increasing the bioavailability of this important mineral. One way to improve calcium availability is to increase intake of products high in calcium, particularly dairy foods. Another alternative would be to increase calcium absorption from foods. Inulin, an oligosaccharide derived primarily from the chicory root, has been shown to have numerous positive effects on human health. One benefit of this substance is its effect on intestinal flora. This product enhances growth of favorable bacteria while retarding growth of harmful bacteria. One of the most promising aspects of inulin is its ability to increase the intestinal absorption of calcium. Inulin additive research has been proven to enhance calcium absorption without increasing caloric intake. One study has shown a 20% increase in calcium absorption from yogurt and fermented dairy beverages with only half of the normal usage level. With new technology and the added benefits of inulin, bone loss could be a major concern of the past, and a minor concern for the future.

Key Words: calcium, dairy foods, inulin

1996 Conjugated linoleic acid: Cancer prevention from dairy products . B. E. Dixon*, *University of Kentucky, Lexington, KY*.

Conjugated linoleic acids (CLA) are fatty acids produced by ruminants that are found in meat and dairy products. After the discovery of CLA in meat, a synthetic form of CLA was developed to use in initial research on laboratory animals. In rodents where cancer was induced, consumption of a diet with high levels of this synthetic CLA reduced the incidence of breast, colon, prostate and skin cancer in the order of 50%. Approximately 40% of synthetic CLA are found as the *cis-9, trans-11* form, the isomer responsible for its anti-carcinogenic effects. In natural dairy products, however, at least 90% of CLA are found as the *cis-9, trans-11* isomer. Recent studies feeding butter with high CLA levels to rodents have indicated a similar decrease in cancer incidence and severity. Butter with high concentrations of CLA decreased mammary cancer in one study with rats and colon cancer in another rat model. Similar effects on humans consuming a diet high in CLA can be expected; thus, CLA have great potential in the diet as an anti-carcinogen. Dairy products that include milk fat with increased levels of CLA have a broad potential market. Milk with increased CLA content can be processed with little effect on CLA levels or anti-carcinogenic benefits. Taste tests have shown that butter and milk with high CLA content are considered acceptable by a majority of samplers. Based on a survey, these consumers