The use of trace mineral sources complexed to organic molecules are improved to absorb and metabolic systems in birds. The present study proposed to evaluate the effects of supplementing zinc (Zn), manganese (Mn), copper (Cu), iron (Fe), and selenium (Se) amino acid complexes, at reduced levels, replacing their original inorganic sources, on performance and internal/external egg quality of laying hens. Four hundred Lohmann White laying hens from 78 to 98 weeks of age were housed in cages and assigned to 4 treatments in a completely randomized design, with 10 replicates and 10 birds per experimental unit. Treatments (T) consisted of 4 diets in which the inorganic mineral source was fully replaced by a source of amino acid-complexed microminerals (AACM), with supplementation levels reduced by 30%, 50%, and 60%. The control diet (T1) contained only inorganic mineral sources at the following levels: 60 ppm Zn, 60 ppm Mn, 7 ppm Cu, 40 ppm Fe, 0.2 ppm Se, and 2.0 ppm iodine (I). Treatments including AACM were as follows: T2) 100% AACM, 42 ppm Zn, 42 ppm Mn, 28 ppm Cu, 2.14 ppm Fe, and 1.4 ppm I (inorganic mineral source-IM); T3) 100% AACM with 30 ppm Zn, 30 ppm Mn, 3.5 ppm Cu, 20 ppm Fe, 0.10 ppm Se, and 1.4 ppm I (IM); and T4) 100% AACM with 24 ppm Zn, 24 ppm Mn, 2.8 ppm Cu, 16 ppm Fe, 0.08 ppm Se, and 1.4 ppm I (IM). Data were subject to ANOVA and Tukey’s test (P < 0.05). Supplementation of AACM with a 60% reduction significantly increased egg production, egg weight, and egg mass, compared with inorganic sources. Improved results were obtained with reduced levels of trace mineral supplementation. The treatment with a 60% reduction in trace mineral supplementation level enhanced measured results compared with other treatments. Birds fed inorganic trace mineral sources, at recommended levels, had sub-optimal performance. Birds fed AACM with a 60% reduction showed the best feed conversion rate per egg mass and per egg dozen the result in the most efficient conversion per egg mass and per dozen eggs. For egg-related traits, a significant difference was found in shell thickness, for which the diet including AACM at 60% of the control treatment level provided better results than all other treatments. Dietary supplementation with AACM for layers in the production stage improves both performance and egg-quality traits.

Key Words: amino acid complexed minerals, egg quality, laying hen, trace mineral

Micromineral nutrition of laying hens is one of the most important factors to be considered when evaluating the role of nutrition in improving performance and egg quality. Therefore, this study was conducted to evaluate the effects of supplemental zinc (Zn), manganese (Mn), and copper (Cu) from different sources [inorganic mineral (IM), amino acid complexed minerals (AACM), and glycinate minerals (GM)] in laying hen diets, on performance and internal/external egg quality. Five hundred 78- to 97-week-old Lohmann White laying hens were distributed in a completely randomized design with 5 treatments, 10 replications per treatment, and 10 birds per replicate. Treatments were a 2 × 2 factorial arrangement plus an inorganic control. The factors were 2 sources of Zn, Mn, and Cu (AACM or GM) at 2 levels (low; 20, 20, and 3.5 ppm of Zn, Mn, and Cu, respectively; and high, 40, 40, and 7 ppm of Zn, Mn, and Cu, respectively). The inorganic control diet contained Zn, Mn, and Cu at the high levels (40, 40 and 7 ppm, respectively). Iron, Se, and I were supplemented from inorganic sources at the same levels in all treatment diets. Data were submitted to ANOVA, with means compared by orthogonal contrasts (trace mineral source, level, and source × level) when P < 0.05. Laying hens fed AACM had better (P < 0.05) egg output (%), egg mass (g/bird/d), FCR (g:dz; g:egg mass), egg shell thickness (mm), albumen height (mm), and Haugh units compared with hens fed diets containing inorganic trace mineral and the glycinate complex. These data show clear differences in micromineral sources, with amino acid complexes resulting in superior performance compared with glycinate and inorganic mineral sources for laying hens.

Key Words: complexed minerals, eggshell thickness, eggshell quality, glycinate, Haugh unit

Amino acid complexed minerals (AACM) have been developed with the intention of improving performance, as they are easily absorbed by the animal. Microminerals play an important role in the metabolic function of birds. The objective of this study was to evaluate the effect of feeding amino acid complexed zinc (Zn), manganese (Mn) and copper (Cu) during initial and growing phases, on productive performance of the pre-layer phase of laying hens. A total of 800 birds from Lohmann Brown Lite laying hens were used. Birds were housed in cages equipped with a trough-type feeder and a nipple-type drinker. The experiment followed bird development from 106 to 182 d of age, lasting until peak production. Laying hens were distributed to treatments according to a completely randomized design, with 20 replicates per treatment and 20 birds per replicate. The control diet was supplemented with 70, 70 and 8 ppm Zn, Mn and Cu, respectively, from inorganic mineral sources (IM). This was compared with a diet containing 40, 40 and 2.75 ppm Zn, Mn and Cu, respectively, from IM plus 30, 30 and 5.25 ppm Zn, Mn, and Cu, respectively, from AACM. At the end of the experiment 40 birds were selected for sampling, according to the average body weight of each plot. Productive development (egg mass, egg output), weight of tibia, reproductive organs, liver and eggs, follicular hierarchy and blood parameters (hormones, leucogram and hemogram) were evaluated. Data were submitted to ANOVA with means compared by Student’s t-test (P < 0.05). Laying hens fed AACM reached 50% of egg output 2 d earlier (P < 0.01) than those fed IM. Significant differences were observed between
treatments for oviduct weight ($P < 0.01$) and red blood cells ($P < 0.05$), eosinophils ($P < 0.01$), basophils ($P < 0.01$), total white blood cells ($P < 0.05$) and total $T_h$ ($P < 0.05$) for the birds fed AACM compared with those fed IM. The treatment AACM also affected tibia weight presenting heavier tibia values ($P < 0.05$) than birds receiving IM. The follicular hierarchy wasn’t affected. Supplementation AACM in laying hen diets beginning at the initial phase improved bone development and oviduct weight, as well, change at blood parameters providing a best response at the starting of egg output.

**Key Words:** complexed minerals, mineral source, pre-lay, semi-heavy layer

### 207 Effect of thermal stress in the first days of layer-type chicks and the use of amino acid complexed minerals to mitigate these effects. W. R. L. Medeiros-Ventura*1, C. B. V. Rabello1, M. R. Barros1, R. V. Silva Junior1, H. B. Oliveira1, A. G. Faria1, C. G. Pereira1, A. F. Silva1, M. J. B. Santos1, L. H. Ferreira1, J. S. Barros1, and A. K. B. A. T. Fireman2, 1Universidade Federal Rural de Pernambuco, PE, Brazil, 2Zinpro Corporation, Eden Prairie, MN, USA.

Two experiments were designed to evaluate amino acid complexed (AACM) zinc (Zn), manganese (Mn), and copper (Cu) as partial replacements for their inorganic counterparts, with and without thermal stress in the first days of layer type chicks. The first trial was completed under thermoneutral conditions during the whole experimental period. Average daily temperatures were 31.57 ± 1.51°C, and 31.81 ± 1.82°C overnight (6 p.m. to 6 a.m.), during d 1 to 15. The second trial submitted chicks to cold stress conditions during the first 15 d of life. Average daily temperature for birds in this trial was 30.33 ± 1.08°C, while overnight temperatures were 27.01 ± 1.71°C. For each trial, 1200 one-day-old Lohmann Brown lite chicks were used in a completely randomized design, with 2 treatments and 20 replications of 30 birds per experimental unit (cage). The treatments consisted of a control diet containing inorganic minerals (IM) with levels of 70, 70 and 8 ppm of Zn, Mn and Cu, respectively, and another diet containing 40, 40 and 2.75 ppm of inorganic Zn, Mn and Cu, respectively + 30, 30 and 5.25 ppm of Zn, Mn and Cu, respectively from AACM. Body weight, uniformity, and feed intake were recorded weekly. The experimental period lasted 35 d in each of the 2 studies, with 3 chicks per group harvested for organ and tibia evaluation. Performance parameters (BW, BWG, FI, FCR, FI) in the plasma of broiler chickens were measured at 43 d of age. In mice, 6 replicate samples were measured to measure hormonal dosages, complete blood count, and serum biochemistry. Data were analyzed through ANOVA and regression using SAEG (2007). Models were chosen based on significance of regression coefficients using the t-test, and coefficient of determination, adopting the level of up to 0.05 probability for both. Mean body temperature had linear behavior at 42 d of age ($P < 0.05$). There was no effect of treatment on absolute and relative weight of lymphoid organs ($P > 0.05$). For reducing plasma corticosterone concentration, supplementing 0.75 ppm Cr-AA is recommended, while 0.47 and 0.66 ppm Cr-AA, respectively, is suggested to increase blood concentrations of T3 and T4. There was a quadratic ($P < 0.01$) response for blood concentration of heterophiles, with the greatest concentration being obtained by supplementation of 0.63 ppm Cr-AA. Also, quadratic responses were observed for total cholesterol ($P < 0.05$), glucose ($P < 0.01$), and triglycerides ($P < 0.05$) in the plasma of broiler chickens, with greater reduction responses obtained by supplementing 0.63, 0.92, and 0.49 ppm Cr-AA, respectively. Dietary supplementation of Cr-methionine improves the plasma and hormonal biochemical profile of broilers reared under heat stress.

**Acknowledgements:** Zinpro Animal Nutrition and UFV

**Key Words:** blood metabolite, chromium, hormones, heat stress cyclic

### 208 Physiological variables of broiler chickens reared under heat stress and fed diets supplemented with chromium methionine. F. S. Dalóllo*1, A. K. Fireman2, L. F. T. Albino1, and D. Ladeira da Silva1, 1Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, 2Zinpro Animal Nutrition, Piracicaba, São Paulo, Brazil.

Heat stress in broilers decreases plasma concentration of hormones, changes the blood profile, causes lymphoid organ involution, and increases corticosterone, contributing to a reduction in productive performance. Chromium acts by stimulating insulin and the metabolism of carbohydrates, proteins, and lipids. Thus, it promotes improvement of physiological parameters when broilers are exposed to heat. The objective of this study was to evaluate the effect of Cr-methionine (Cr-AA) supplementation in diets for broilers reared under cyclic heat stress (33°C per 12 h) from 22 to 43 d of age. A total of 336 21-d-old male Cobb 500 broilers were distributed in a randomized complete block design with 4 blocks (each climatic chamber), with 6 treatments (0, 0.10, 0.20, 0.40, 0.80, and 1.20 ppm Cr-AA), 8 replicates per treatment, and 7 birds per replicate. Body temperature, lymphoid organs, and concentration of hormones and blood metabolites were measured. At 43 d of age, blood samples of 2 birds with mean weight of each experimental plot (±5%) were collected, totaling 96 samples to measure hormonal dosages, complete blood count, and serum biochemistry. Data were analyzed through ANOVA and regression using SAEG (2007). Models were chosen based on significance of regression coefficients using the t-test, and coefficient of determination, adopting the level of up to 0.05 probability for both. Mean body temperature had linear behavior at 42 d of age ($P < 0.05$). There was no effect of treatment on absolute and relative weight of lymphoid organs ($P > 0.05$). For reducing plasma corticosterone concentration, supplementing 0.75 ppm Cr-AA is recommended, while 0.47 and 0.66 ppm Cr-AA, respectively, is suggested to increase blood concentrations of T3 and T4. There was a quadratic ($P < 0.01$) response for blood concentration of heterophiles, with the greatest concentration being obtained by supplementation of 0.63 ppm Cr-AA. Also, quadratic responses were observed for total cholesterol ($P < 0.05$), glucose ($P < 0.01$), and triglycerides ($P < 0.05$) in the plasma of broiler chickens, with greater reduction responses obtained by supplementing 0.63, 0.92, and 0.49 ppm Cr-AA, respectively. Dietary supplementation of Cr-methionine improves the plasma and hormonal biochemical profile of broilers reared under heat stress.

**Acknowledgements:** Zinpro Animal Nutrition and UFV

**Key Words:** chick, cold stress, immune response, mineral source, performance

### 209 Gene expression of HSP 70 and IGF-1 in broiler chickens reared under cyclic heat stress and fed diets supplemented with chromium methionine. F. S. Dalóllo*1, A. K. Fireman2, L. F. T. Albino1, D. Ladeira da Silva1, and H. Cedraz1, 1Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil, 2Zinpro Animal Nutrition, Piracicaba, São Paulo, Brazil.

Heat stress in broilers induces oxidative stress and cell damage to the extent that heat shock protein (HSP) expression can be measured as indicative of its effect on yield. Insulin-like growth factor (IGF-1) is important for protein synthesis, and for reducing proteolysis in broilers, especially under heat stress conditions. Chromium acts by increasing sensitivity to insulin acting on IGF-1. In addition, Cr reduces cellular
oxidative damage in heat stress situations. Thus, the study objective was to evaluate the effect of chromium methionine (Cr-AA) supplementation of broiler diets, on gene expression of HSP70 and IGF-1, when broilers were reared under cyclic heat stress conditions from 22 to 43 d of the production period. For analyses of HSP70 and IGF-1 genes in the pectoralis major muscle, a total of 24 broilers were used in a completely randomized design, with 4 replicates for each of 6 treatments. Treatments consisted of 6 Cr-AA levels (0, 0.10, 0.20, 0.40, 0.80 and 1.20 ppm), added on top of broiler diets. On d 43, broilers were kept under heat stress (33°C) for 12 h, then they were harvested and the pectoral regions were removed. Statistical analysis of gene expression data used the % QPCR_MIXED macro (STEIBEL et al., 2009) in SAS v9.0 to determine if there was a difference between treatments, contrasts were made between factors that compare them. In this statistical model, the effect of Cr-AA was considered fixed, and the effect of genes was considered random. In this way, authors were able to test all possible linear combinations between the levels of these factors. Statistical significance was considered for P-values less than 0.05. There was an effect (P < 0.05) of Cr-AA supplementation on the relative expression of HSP-70 at all supplementation levels in relation to the control diet. There was also an effect on the relative expression of IGF-1 in broiler chicks for supplementation levels of 0.80 and 1.20 ppm Cr-AA, when compared with the control diet. Dietary supplementation of chromium methionine decreases the expression of HSP-70, and increases expression of IGF-1, in the breast of broiler chickens raised in cyclic heat stress. Thus, supplementation of Cr-AA at 0.80 ppm is recommended to reduce cell oxidative damage in broiler chickens raised under heat stress.

Acknowledgements: Ziinpro Animal Nutrition and UFV

Key Words: chromium, gene expression, heat shock protein, insulin


In present study effects of different levels of butyric and propionic acid and their combination was tested on growth performance and carcass characteristics in Japanese quails (Coturnix coturnix japonica). One hundred twenty quails were randomly divided into 4 groups (A, B, C and D) with 3 replicates in each group (10 birds/replicate) and birds were reared in floor pens. A basal diet was fed to control group A and other diets B, C and D were made by supplementation of basal diet with 0.25% butyric, 0.25% propionic and 0.25% from each acid, respectively. Each diet was fed to specific group. This experiment was lasted for 35 d under uniform management conditions. Data regarding weekly body weight, feed intake and mortality were recorded and at the end of the trial, carcass data, weights of heart, liver and gizzard were recorded and analyzed using PROC GLM procedure of Statistical Analysis System (SAS, 2009) under completely randomized design. Body weight gain (P < 0.05) and feed conversion ratio (P < 0.05) were improved in birds receiving diet containing butyric acid as 0.25% than other diets during starter and overall phases. Feed intake (P < 0.05) was reduced in control group B as compared with other treatments starter and overall phases. But experimental diets were similar (P > 0.05) regarding feed consumption, weight gain and FCR during finisher phase. Carcass percentages and abdominal organs weights were remained unaffected (P > 0.05) by dietary treatments. Based on the results of this study, it is concluded that butyric acid supplementation as 0.25% has beneficial effects on Japanese quail’s growth performance and feed conversion ratio.

Key Words: butyric acid, propionic acid, growth performance, Japanese quail


An experiment was conducted to investigate the effects of different dietary supplementation levels of zinc (Zn) on live performance and carcass characteristics of Japanese quail (Coturnix japonica). Two hundred and four day-old chicks of Japanese quails were purchased for local hatchery and were divided into 4 experimental groups (CG, Zn60, Zn80 and Zn100) with 4 replicates under each group (15 chicks/replicate). Group CG was control group and was fed basal diet other groups Zn60, Zn80 and Zn100 fed basal diet supplemented with Zn @ 60, 80 and 100 mg/kg, respectively. All birds were provided similar management conditions and birds were reared in floor pens for 35days. Data regarding growth performance was collected on weekly bases and 4 birds per replicate were slaughtered to assess the carcass characteristics at the end of experiment. Data was analyzed using ANOVA technique under completely randomized design and means were compared using Tukey’s test. Significant (P < 0.001) improvement in weight gain of experimental groups was found compared with control group but no difference (P > 0.05) was found among different Zn levels. Highest weight gain (126.37g) was found in group Zn60 compared with CG (118.95g). Feed intake was reduced (P < 0.001) and FCR was improved (P < 0.001) in group Zn60. Better FCR (2.98) was found in group Zn60 and there was a difference of 0.81 in FCR in control group with Zn60. Significantly (P < 0.005) highest dressing percentage (54.98%) was found in group Zn100 but relative weight of giblet organs remained unaffected (P > 0.05). The use of Zn had beneficial effect on growth performance may made the quail farming more profitable as Zn supplementation increased the profit margin. It can be concluded that Zn supplementation through feed has beneficial effects on Japanese quail’s growth performance and dressing percentage.

Key Words: zinc, growth performance, carcass characteristics, Japanese quail


Experiment was conducted to evaluate the effect of vitamin C and manganese (Mn) independently or in combine form under hot climate on growth and carcass characteristics of Japanese quail (Coturnix Coturnix japonica). For this purpose, 240 d-old Japanese quails were purchased and distributed into 16 replicated (15 chicks/replicate). Four replicates were allotted to each of the 4 treatments experimental group (control, C220, Mn80 and C.Mn). Chicks in control group fed basal diet without supplementation of vitamin and mineral, group C220 and Mn80 were supplemented with vitamin C (220mg/kg) and Mn (80mg/kg), respectively. In group C.Mn both vitamin C (110mg/kg) and Mn were supplemented with vitamin C (220mg/kg) and Mn (80mg/kg), respectively.
(40mg/kg) were supplemented in diet. All diets were isonitrogenous (CP 24%) and isocaloric (2900 kcal/kg) and fed for 35 d. Data on feed intake, weight gain and feed conversion ratio were recorded on weekly bases and 2 birds per replicate were slaughter to check dressing percentage and giblet organs weight at the end of experiment. Data were subjected to ANOVA technique under completely randomized design and means were compared with check significant difference ($P < 0.05$) using Least Significance Difference test. Significant ($P < 0.05$) improvement in all parameters of growth performance was observed in all experimental groups compared with control group but not difference ($P > 0.05$) was found among experimental groups. Highest weight gain (142.25g), dressing percentage (63.58%) and better FCR (2.78) were found in group C.Mn. Economic analysis showed that profit margin was increased by vitamin and mineral supplementation. On the bases of present findings, it is concluded that quails can be reared under hot climate by feeding on vitamin C with Mn supplemented diet without compromising their growth performance.

**Key Words:** vitamin C, manganese, growth performance, Japanese quail