The effect of dietary supplementation of calcium pidolate with or without vitamin D metabolite on production performance and egg quality in commercial laying hens

A thesis submitted by

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I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

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Abstract

Two experiments were conducted on commercial layer hens to study the effects of dietary supplementation with two levels of 25-hydroxycholecalciferol (25(OH)D_3) and two levels of calcium pidolate (with or without 25(OH)D_3) on production performance and egg quality. Experiment 1 was conducted using 90 Hy-Line Brown layer hens from 19 to 80 weeks of age and commenced in November 2012. Birds were divided into three groups of 30 hens as follows: group A (control group) fed with normal commercial layer mash feed, and groups B and C (treated groups) fed with normal commercial layer mash feed plus 0.5 g of 25(OH)D_3 [premix (68.9 µg 25(OH)D_3)] per kg of feed and 1 g of 25(OH)D_3 [premix (137.8 µg 25(OH)D_3)] per kg of feed, respectively. Experiment 2 was conducted using 147 Lohmann Brown layer hens from 21 to 80 weeks of age and commenced in March 2014. Birds were divided into 7 groups of 21 birds as follows: group 1 control group was fed with normal commercial layer mash feed, the other 6 groups were fed with normal commercial layer mash feed plus the following designed additives: groups 2 and 3 (0.3 and 0.6 g of calcium Pidolate per kg of feed, respectively); groups 4 and 5 (0.3 g of calcium Pidolate plus 0.5 g of 25(OH)D_3 [premix (68.9 µg 25(OH)D_3)] and 1 g of 25(OH)D_3 [premix (137.8 µg 25(OH)D_3)] per kg of feed, respectively); groups 6 and 7 (0.6 g of calcium Pidolate plus 0.5 g of 25(OH)D_3 [premix (68.9 µg 25(OH)D_3)] and 1 g of 25(OH)D_3 [premix (137.8 µg 25(OH)D_3)] per kg of feed, respectively). Layer mash feed used in both experiments was formulated by a nutritional consultant and mixed by a specialist feed company. Supplemental 25(OH)D_3 premix and calcium pidolate were added to experimental feed according to the doses described above, using the feed mixing room at the University of New England. Birds were given ad libitum access to the feed. The measurements applied for both experiments included: bird body weight, feed intake, egg production, shell colour, the amount of cuticle present on the eggshells, eggshell translucency score, egg weight, shell weight, percentage shell, shell breaking strength, shell deformation, average shell thickness, Haugh unit, albumen height, yolk colour score. Bone breaking strength, blood haematocrit, and blood electrolytes (Ca^{++}, Cl^{-}, K^{+}, and Na^{+}) were measured only at 80 weeks of age. Specialised equipment available in the Egg Quality Laboratory and other Laboratories at UNE were used for these analyses.

In the first experiment, body weight increased until 60 weeks of age, and then remained relatively consistent until the end of the study. Feed intake was relatively unaffected by the treatment groups. Weekly egg production increased to the mid lay stage and then decreased in the late lay stage and was higher than the breed standard during the whole period of lay. Eggshell colour as measured by the L* value before staining was lighter for all groups to 75 weeks of age and then remained relatively stable to 80 weeks of age. During the period of lay, the single score value was higher for Group A than for Groups B and C indicating greater cuticle coverage for the control group. There was no significant difference among the groups for translucency score values. Egg weight was significantly lower for Group B than for Groups A and C and increased with increasing flock age. Group C had the highest shell weight and percentage shell followed by Group A then Group B which was the lowest. There was no significant difference among the three groups for shell breaking strength. Group C birds had lower deformation to breaking point than Groups A and B. Shell breaking strength and shell deformation decreased with increasing flock age. Albumen quality, as measured by albumen height and Haugh Unit, decreased with increasing flock age and was slightly lower in the 25(OH)D_3 supplemented groups. Yolk colour score was lower in Group B than Groups A and C. For bone breaking strength, Group A was higher than Group B with Group C intermediate for humerus, and Group A was higher than Groups B and C for femur breaking strength. There were no significant differences among the three groups for blood hematocrit and electrolytes.

In the second experiment, body weight increased until 37 weeks of age, and then remained relatively consistent until the end of the study. Feed intake was relatively unaffected by the treatment groups except the group receiving the recommended dose of calcium pidolate which consumed more feed. Weekly egg production increased to the mid lay stage and then decreased in the late lay stage and was higher than the breed standard after the peak of lay. L* value before staining showed a decrease in brown eggshell colour with increasing flock age. Shell reflectivity indicated that the lightest eggshell colour for all groups was in the mid lay period and became slightly darker in the late period of lay. The amount of cuticle on the eggshell was higher for the control group which was similar to the groups receiving Hy-D with a single dose of calcium pidolate. The eggshell quality variables showed inconsistent results among the groups. When the eggshell quality variables were analysed for all groups combined, the translucency score increased with increasing flock age; egg weight was lower in the early lay stage than the similar mid and late lay stages; shell weight was highest in mid lay followed by early lay then the late lay stage; percentage shell, shell breaking strength, shell deformation, and average shell thickness decreased with increasing flock age. Internal egg quality was highest for Group 2 and lowest for Group 1; Groups 5, 6, and 7 were similar to Group 2 only for yolk colour scores. Albumen quality decreased with increasing flock age; whereas, yolk colour score increased with increasing flock age. There were no significant differences among the groups for bone breaking strength, blood haematocrit and electrolytes.

There are similarities and differences between the results of the two experiments. Similarities were: weekly egg production increased to the mid lay stage and then decreased in the late lay stage; all eggs were lighter in shell colour with increasing hen age as measured by the L* value; lower amount of cuticle present on the eggshells resulted from inclusion of either dose of Hy-D on its own, or from a single dose of calcium pidolate on its own; no significant difference among the groups and similar pattern for percentage shell with increasing flock age; shell breaking strength, shell deformation, and albumen quality decreased with increasing flock age; no significant differences among the groups in either experiment for blood haematocrit and electrolytes; there was an interaction between treatment group and stage of experiment for feed intake, shell reflectivity, and yolk colour score. Differences were: body weight increased until 60 weeks of age in the first experiment and until 37 weeks of age in the second experiment; the group receiving the recommended dose of calcium pidolate consumed more feed; weekly egg production was higher than the breed standard numbers during the whole period of lay in the first experiment and after the peak of lay in the second experiment; the eggs collected from the oldest hens in the second experiment had lower shell reflectivity than those in the first experiment at the same period of lay; the egg shell colour in the second experiment was darker than that in the first one for all laying stages; egg weight, shell weight and percentage shell were higher in the first experiment than the second one; the average shell thickness in the second experiment decreased with increasing the flock age, whereas it improved in the mid lay stage and then declined to the early stage level in the first experiment; shell breaking strength was not affected by adding Hy-D, on its own, to the hens' diet but decreased when calcium pidolate, either on its own, or when either dose of calcium pidolate was incorporated with the opposite dose of Hy-D in the diet; only the higher level of Hy-D, on its own, improved average shell thickness and percentage shell, but inclusion of calcium pidolate with or without Hy-D, resulted in decreased average shell thickness; adding Hy-D on its own to the hens' diet decreased albumen quality, but when the calcium pidolate was added on its own or with Hy-D, the albumen quality was improved; the strength of the humerus and femur bones was lowered by inclusion of the single dose of Hy-D, but the double dose lowered only the strength of femur; the strength of humerus, femur and tibia bones was not affected by inclusion of calcium pidolate, on its own or with combination of Hy-D; there was an interaction between treatment groups and stage of experiment for egg production, L* value before staining, and percentage shell in the first experiment, and for single score value and eggshell weight in the second experiment; there was no significant effect of treatment group on body weight and shell breaking strength in the first experiments and on translucency score in the second experiment.

In general, adding double the recommended dose of Hy-D to a fully formulated commercial layer diet improved eggshell quality, whereas calcium pidolate improved albumen quality. When the two supplements were incorporated together, results were inconsistent. In the commercial situation, any decision to add Hy-D or calcium pidolate to the feed of laying hens would need to take into the account the cost of the supplements in relation to the potential benefits.

Publications arising from this thesis

1- Al-Zahrani, K.S. and Roberts, J.R. (2013). Effect of 25-hydroxycholecalciferol supplementation on production performance in commercial laying hens. Recent Advances in Animal Nutrition, University of New England, Armidale.

2- Al-Zahrani, K.S. and Roberts, J.R. (2014). Effect of 25-hydroxycholecalciferol supplementation on egg quality, body weight and feed intake in commercial laying hens. Proceedings of Australian Poultry Science Symposium. 25:131-133.

3- Al-Zahrani, K.S. and J.R. Roberts (2014). Influence of dietary 25-hydroxycholecalciferol level on production performance and egg quality of Hy-Line brown laying hens. 10th Asia Pacific Poultry Conference, Korea.

4- Al-Zahrani, K., & Roberts, J. (2015). The effect of supplementation of two levels of calcium pidolate and two levels of 25-hydroxycholechaciferol on egg quality in commercial laying hens. EggMeat Conference, France.

5- Al-Zahrani, K.S. and Roberts, J.R. (2015). Effect of supplementation with two levels of 25-hydroxycholecalciferol on egg internal and external quality in commercial laying hens. Proceedings of Australian Poultry Science Symposium, 26: 40-43.

6- Al-Zahrani, K.S. and Roberts, J.R. (2016). The effect of dietary supplementation with calcium pidolate and 25-hydroxycholecalciferol on egg quality in commercial laying hens, Proceedings of Australian Poultry Science Symposium, 27: 141-44.

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Abbreviations

FAO	Food and Agricultural Organization
Ca	Calcium
Hy-D	Twenty five hydroxycholecalciferol
P `	Phosphorus
PTH	Parathyroid hormone
GH	Growth hormone
UK	United Kingdom
US	United States
BAB	Babcock B-300
ISAB	ISA-Brown
BL	Brown Leghorn
NPP	Nonphytate phosphorus
g	Gram
µg	Microgram
kg	Kilogram
pH	Power of hydrogen
AP	Available phosphorus
TP	Total phosphorus
TD	Tibial dyschondroplasia
TSS	Technical Services and Supplies
SCI	Specular component included
SCE	Specular component excluded
RBC	Red blood cells

Cl^-	Chloride
K^+	Potassium
Na^+	Sodium
cm	Centimetre
NS	Not statistically significant
C	Control
1H	Single dose of Hy-D
2H	Double dose of Hy-D
mmol/L	Millimoles per litre
ppm	Parts per million
1P	Single dose of calcium pidolate
2P	Double dose of calcium pidolate