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EFFECT OF DIETARY NPP LEVEL AND PHYTASE SUPPLEMENTATION ON THE LAYING PERFORMANCE OVER ONE YEAR PERIOD

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Original scientific paper

SUMMARY

Our trial was aimed to study the effect of different dietary non-phytin phosphorus (NPP) levels with and without phytase enzyme supplementation on laying performance and eggshell quality of Tetra SL-LL in the last 25 weeks of the long-term (17 months) egg production. A total of 69 Tetra SL-LL layers were allocated into 3 dietary treatments. Two diets with different levels of NPP (2.45 or 2.15 g/kg, HP and LP, respectively) were formulated, and 0 or 300 FTU/kg phytase enzyme was added to low NPP feed (LP and LP+E, respectively). Dietary Ca was uniformly adjusted (38.2 g/kg) to feed in each treatment. In the course of the trial, intensity of egg production (%), egg weight (g/egg), number of the broken eggs and feed intake (g/d/bird) were recorded. Every 2 weeks 20 eggs per treatment were broken to determine the shell strength and thickness. Our results show that low NPP diet had detrimental effect on the intensity of egg production (P<0.05). However, dietary treatments had no effect on weight of eggs. They significantly affected eggshell thickness (P<0.05), but not egg shell strength (P>0.05) and phytase added to the LP diet resulted the lowest number of broken eggs (P<0.05). In conclusion, NPP content of the layer diet can be reduced from 2.45 to 2.15 g/kg in the last 25 weeks of the elongated laying term (12-17 month of laying), if supplemented with 300 FTU/kg phytase enzyme without compromising the egg production, and in the same time it can improve eggshell quality and reduce the number of broken eggs.

Key-words: laying hen, phosphorus, phytase, long-term laying period, egg production, eggshell quality

INTRODUCTION

In practice, the leading breeding companies keep layers in production up to 90-100 week of age (babolnatetra.com, hyline.com, isapoultry.com). It is well documented that egg shell quality problems arise towards the end of the laying period causing considerable economic loss. Therefore, the precise Ca and P supply is crucial in that period (Tischler et al, 2013). Addition of phytase to high phytate containing diets improves P digestibility due to release of bounded P in cereal grains and oilseed meals. Several studies examined different doses of phytase in laying hens to evaluate the needs for improving performance parameters.

Van der Klis et al (1997) found that deprivated P containing diets supplemented by 250 FTU/kg enzyme supported similar egg production as fed adequate P diet, and at the same time, 500 FTU/kg phytase added to low P diet did not result in further improvement on laying performance. Some other publication also showed that providing supplementary 300 FTU/kg to a low NPP diet can be efficient for improving laying intensity and egg shell quality (Lim et al, 2003; Augspurger et al, 2007) even for older (70-76 wk of age) intensive laying hens (Gordon and Roland, 1997, Boling et al, 2000).

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Therefore, the aim of our study was to confirm the effect of dietary NPP level and phytase supplementation on egg production and egg shell quality in the last interval of the elongated (from 12 to 17 month) laying period.

MATERIAL AND METHODS

In the trial, three diets were fed to 69 Tetra SL-LL hens from 44 to 68 week of age. Treatments consisted of a control feed with 2.45 g/kg non-phytin phosphorus (HP), a 12% reduced 2.15 g/kg NPP (LP) and a 2.15 g/kg NPP plus 300 unit/kg phytase enzyme (LP+E) diets with constant dietary energy (11.6 MJ AMEn/kg), protein (160 g/kg), Ca (38.2 g/kg) and amino acid content (8.2 g Lys, 7.3 g Met+Cys per kg feed). Composition and nutrient content of HP and LP diets are showed in Table 1. Layers performance was examined in the last 6 months of the elongated (17 months) laying period. Egg production and egg weight were daily recorded by cages, whereas feed intake was measured weekly. Performance of the hens were characterized by intensity (%), egg weight (g/egg), broken eggs (egg/d/cages) as well as feed intake (FI, g/d/bird) and feed conversion ratio (FCR, kg FI/kg egg mass). Every two weeks, 20 eggs per treatment were collected and broken to determine egg-shell strength and thickness. Zwick Roell ZOO5 type of instrument was used for cracking eggshell. Thickness was measured by Mitutoyo electronic micrometer with 0.001 mm accuracy averaged from three measurements per egg. Data were analysed by two-way ANOVA (SAS, 2004), as follows: $\mathbf{Yijk = \mu + Pi + Tj + Pi{*}Tj + e_k}$, where: Yijk = dependent variable, μ = general mean, Pi = effect of dietary treatment (i=3; HP, LP, LP+E), Tj = effect of laying time (as for feed intake, feed conversion ratio, egg weight and egg shell strength j=6; M12-M17, as for egg production, broken eggs and egg shell thickness j=25; wk44-wk68), Pi*Tj = effect of interactions, e_k = undefined error. Statistical significance was based on a 5% probability level.

RESULTS AND DISCUSSION

There was no interaction between dietary treatments and laying period at any of the examined parameters.

Table 1. Composition and nutrient content of feed in dietary treatments HP and LP

Ingredients (g/kg)	HP	LP+E	LP	Nutrients (g/kg)	HP	LP+E	LP
Corn, grain	653.7	654.6	658.3	DM[2]	897.0	896.9	896.8
Soybean meal (CP: 47,3 %)	224.0	224.0	224.0	CP[3]	160.0	160.1	160.3
Fat, vegetable	2.0	2.0	2.0	AMEn	11.6	11.6	11.6
MCP[1]	7.3	5.8	0.0	Lysine	8.2	8.2	8.2
Limestone	95.0	95.6	97.8	M+C[4]	7.3	7.3	7.3
Salt	4.0	4.0	4.0	Threonine	6.4	6.4	6.4
L-lysine-HCl	0.8	0.8	0.7	Ca	38.2	38.2	38.2
DL- methionine	2.4	2.4	2.4	tP[5]	5.03	4.71	3.46
L-threonine	0.8	0.8	0.8	Non Phytate-P	2.45	2.15	2.15
Premix 1%	10.0	10.0	10.0	Na	1.6	1.6	1.6

[1]Mono calcium phosphate, [2]Dry matter, [3]Crude protein, [4]Methionin+Cystein, [5]Total phosphorus

Effect of dietary treatments and laying term on the intensity of egg production is showed in Figure 1. Treatment LP unlike HP and LP+E treatments was significantly lower (P<0.0001). Therefore our data suggest that 2.15 g/kg dietary NPP is insufficient to support well egg production. It is well documented that inadequate P supply reduces the laying intensity (Liu et al., 2007). Our data clearly show that there is no difference between the production intensity of hens fed diet with recommended 2.45 g/kg NPP and 2.15 g/kg NPP + 300 FTU. Egg production positioned on 92% at the beginning of the last 25 weeks of the elongated laying period, followed by progressive lowering. In the final weeks it was around 55%, which intensity still might be acceptable for keeping hens in production.

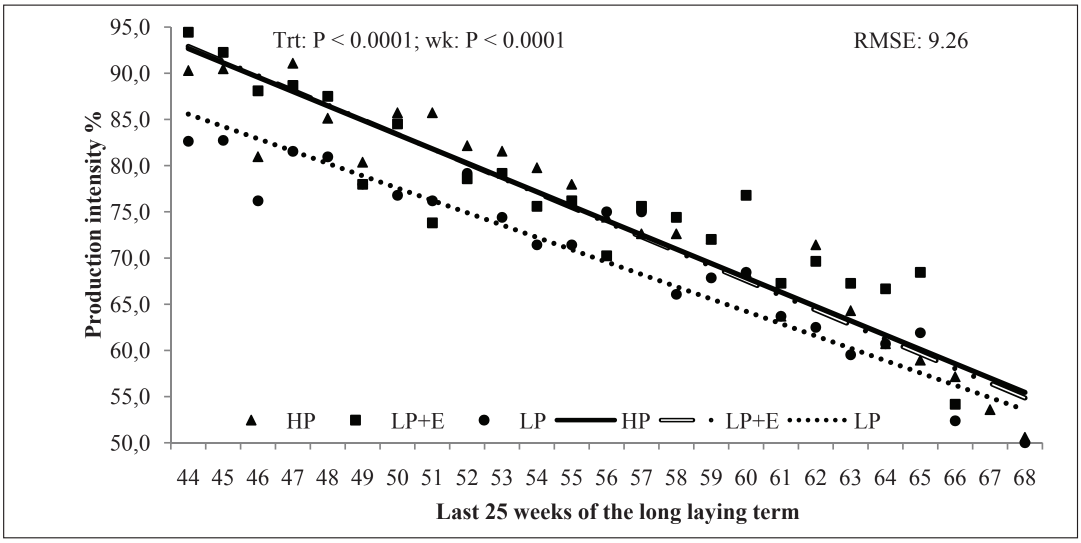

Figure 1. Effect of dietary NPP levels and phytase supplementation on laying intensity %

Mean production intensity % in different treatments were: HP $\dot{x}$=74.0^{A}, LP+E $\dot{x}$=73.8^{AB}, LP $\dot{x}$=69.5%^{B}, respectively

The effect of treatments on the FI, FCR, conversion, egg weight, and egg shell parameters are shown in Table 2. The experimental treatments showed significant differences between LP and LP+E diets (P=0.026) on FI, birds consumed the least from 2.15 g/kg NPP + 300 FTU/kg diet. In the first month of the experimental period layers took 117.0 gram meals daily and consumption was progressively decreased by 99.0 g/day. Jalal and Scheideler (2001) found out that P deprivated birds compensated their P supply by higher feed intake. FCR was significantly affected by trial time: at the beginning of the trial it was lower by 0.47 than in the last month. Dietary NPP levels or phytase supplementation did not affect egg weight, which is in accordance with results of Keshavarz (2003). The average egg weight was ±63 g all along the experimental term being the desirable egg size (M) in the European countries. Due to the high variability, shell strength was affected either by different NPP level or by time factor (P>0.05). Breaking power was approximately 3.5 kg in all three treatments. Considering egg shell quality, shell thickness was affected by both dietary treatments (P<0.001) and time (P<0.011). Leeson et al (1992) reported that 0.35% available phosphorus significantly reduced egg shell quality (P<0.01). Rao et al (2003) found that between 196-336 day of age layers need 2.8 g NPP/kg diet for optimum egg production and egg shell quality. Egg shell was constantly thinner at LP+E treatment compared to HP treatment during the experimental period, but still kept within acceptable range (Arpasova, 2010).

Table 2. Effect of dietary NPP level and phytase supplementation on daily feed intake, feed conversion, mean egg weight, shell strength, and shell thickness

		Feed intake g/day/bird	Feed conversion ratio kg/kg	Egg weight g/egg	Shell strength kg	Shell thickness mm
Treatments[1]	HP	107.8^{AB}	2.36	62.4	3.53	0.344^{A}
	LP+E	104.9^{B}	2.30	62.4	3.59	0.333^{B}
	LP	112.8^{A}	2.29	62.9	3.37	0.339^{AB}
Months[2]	12	117.0^{A}	2.17^{B}	62.0	3.65	0.341^{A}
	13	110.4^{ABC}	2.12^{B}	62.4	3.50	0.339^{AB}
	14	110.9^{AB}	2.25^{AB}	62.2	3.40	0.340^{AB}
	15	108.0^{ABC}	2.24^{AB}	62.7	3.55	0.339^{AB}
	16	104.4^{BC}	2.47^{AB}	63.5	3.45	0.340^{AB}
	17	99.0^{C}	2.64^{A}	62.6	3.50	0.336^{B}
RMSE[3]		13.75	0.53	2.67	1.06	0.03
P ≤[4]	Trt	0.026	NS	NS	NS	0.001
	Month	0.001	0.008	NS	NS	0.010

[1]HP: 2.45 g/kg dietary NPP, LP+E: 2.15 g/kg dietary NPP + 300 FTU/kg phytase, LP: 2.15 g/kg dietary NPP, [2]Last 6 months of the long-term, [3]Root mean square error, [4]Statistical significance

Figure 2 presents that dietary treatments as well as the laying period significantly affected the cracked eggs (P<0.0001; P=0.02, respectively). Approaching the end of the long laying term and considering HP and LP diets the number of broken eggs increases. It is notable that the loss of production due to egg break increased approximately 3 times in HP, two times in LP group and remained at the initial value in LP+E treatment. The number of the broken eggs pro rata to the total produced eggs was 8.03% in HP, 5.55% in LP and no more than 4.12% in LP+E treatment (data are not shown). Summing up the results on egg shell strength, thickness and the number of broken eggs we may hypothesize that egg shell gets more flexible at LP+E diet compared to other treatments. This might be due to a smoother P supply from enzyme released phytate and likely better crystallography parameters.

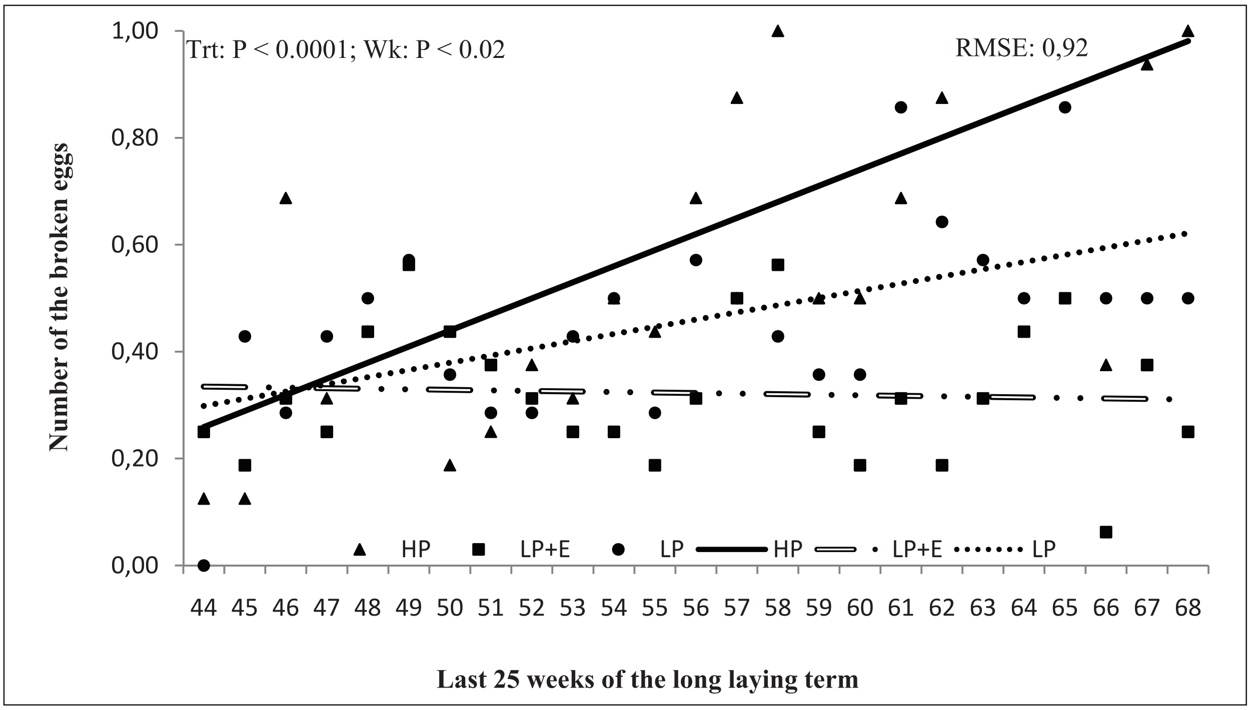

Figure 2. Effect of dietary NPP levels and phytase supplementation on the number of broken eggs

Average broken eggs number of different treatments was: HP $\dot{x}=0.62^{A}$, LP+E $\dot{x}=0.32^{B}$, LP $\dot{x}=0.46^{B}$ eggs, respectively

CONCLUSION

Based on our data, it can be concluded that in the last 25 weeks of the elongated laying term, dietary NPP content can be lowered by 12% if supplemented with 300 FTU phytase per kg feed, without compromising the production intensity and feed consumption of laying hens. Low P diet with phytase supplementation ensures acceptable egg shell strength, even thinner shell but less broken eggs due to likely more flexible shell.

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