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Effect of Dietary Energy and Protein Level and Enzyme Supplementation on Performance and Egg Quality Traits of Laying Hens

Mehran Torki[1*], Mohammad Ehsani[1] and Mohammad Zarei[2]

[1]Department of Animal Science, College of Agriculture and Natural Resources, Razi University, Imam Avenue, Kermanshah, Iran.
[2]Young Researchers Club, Aligodarz, Islamic Azad University, Aligodarz, Iran.

Authors' contributions

Author MT designed the study, managed the analyses of the study and wrote the protocol. Author ME performed the statistical analysis and wrote the first draft of the manuscript. Author MZ managed the literature search.

Original Research Article

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ABSTRACT

Aims: The present study was conducted to determine effect of dietary energy and protein level and enzyme supplementation on performance and egg quality traits of laying hens.
Study Design: A total of 96 Lohman LSL-Lite laying hens (66 weeks of age) were randomly divided in 16 cages with 6 hens per cage. Hens within every four cages (replicates) allotted to feed each of four experimental diets. Collected data were analyzed based on a completely randomized design using GLM procedure of SAS.
Place and Duration of Study: This 6-weeks study was done in the Department of Animal Science, Agriculture Faculty, Razi University.
Methodology: Based on a 2 × 2 factorial arrangement of treatments, four diets consisted of two levels of dietary energy and protein (ME (MJ) and CP%: 11.39, 15 and 10.80, 14.25) and enzyme (0.0 or 0.9 g/kg, Endo-xylanase units/g: 9,000 U/g) were formulated based on the Lohmann catalogue. The first two weeks of experiment was considered as adaptation period and after this the performance data were collected. Egg production and egg weight were daily recorded. Feed intake and feed conversion ratio (FCR) were measured weekly. Egg quality traits were measured at the last week of experiment.
Results: Reduced dietary energy and protein level increased FCR of hens. Diet supplementation by enzyme improved FCR and egg shell weight.

**Corresponding author: Email: torki@razi.ac.ir;*

Conclusion: From the results of the present experiment it can be concluded that dietary enzyme supplementation can improve FCR of laying hens fed diets with reduced level of dietary energy and protein.

Keywords: Energy; enzyme; laying hens; performance; protein.

1. INTRODUCTION

Corn is the main energy source in poultry diets worldwide. Because of availability, wheat is also used, although the level of its diet inclusion is limited often because of its variable chemical composition and high non-starch polysaccharide (NSP) content [1]. Enzyme supplementation of wheat diets is a common practice in commercial feeding of poultry [2,3]. Enzyme supplementation increased egg production and nutrient digestibility and improved feed conversion [4]. However, Mathlouthi et al. [5] failed to demonstrate any beneficial effect of enzyme supplementation on egg production or egg weight of Brown laying hens fed wheat and barley-based diets. Pan et al. [6] did not observe any benefit of enzyme supplementation of diets based on wheat and rye on performance of single comb white Leghorn hens. The reasons for the discrepancies among authors are not known but probably depend on the characteristics of the wheat used and the enzyme sources and their associated activities. The NSP content of wheat, especially of arabinoxylans (pentosans), is variable depending on factors such as cultivar, environmental factors, and storage conditions after harvest [7]. The average of non-starch polysaccharide, soluble, non-soluble and arabinoxylan, for 19 Iranian varieties of wheat were 18.39, 16.21, 1.011 and 4.84 percent, respectively [8]. Additionally, attempts have been made to assign economic value to NSP-degrading enzymes [9]. Energy can be lowered from a diet by enzyme supplementation of wheat based diet through diluting diet using a high fiber ingredient. It is not clear whether these methods yield similar results when NSP enzymes are employed.

The objective of this study was to evaluate the effect of enzyme supplementation of diets with reduced energy and protein level on performance and egg quality traits of commercial laying hens.

2. MATERIALS AND METHODS

2.1 Animals, Treatments and Management

All procedures used in this six-week experiment were approved by the "Animal Ethics Committee of Razi University" and complied with the "Guidelines for the Care and Use of Animals in Research". A total number of 96 Lohmarm LSL-Lite hens, were randomly distributed between 16 cages (n=6), with almost similar production rate and body weight between cages. The hens were placed in wire-floored cages (0.3 m wide×0.4 m length×0.4 m height) arranged in a single tier within a conventional open-sided house. The cages were located in a windowless and environmentally controlled room with the room temperature kept at 21ºC and the photoperiod set at 16 h of light (incandescent lighting, 10 lux) and 8 h dark. After a week of adaptation, the hens were randomly allocated to one of the four experimental diets. Based on a 2×2 factorial arrangement of treatment, four experimental diets consisting of 2 metabolizable energy levels (11.39 and 10.80: ME (MJ/kg) and 2 crude protein levels: CP 15 and 14.25%) and a commercial cocktail enzyme with mostly xylanase activity (Nutrase® manufacturer: chterstenhoek-5, Lille, 2275, Belgium, 0.0 or 0.9 g/kg, Endo-xylanase units/g: 9,000 U/g) were formulated Table 1. Xylanase contained standardized activities of at endo-1, 4b-xylanase (Sylaxyme method, pH = 6)، β- Glucanase (β-Glucazyme method, pH = 4.2) and α-Amylase (Amylazyme method, pH = 6). Enzyme preparations with the used dietary fine particle sizes (dicalcium phosphate, salt, lysine, methionine, premix and sand) were fully mixed with about 5 kg of ground corn and these was added to the other ingredients and were mixed. Water was available *ad* libitum throughout the experiment. Feed consumption was measured on a daily basis. Egg quality characteristics were measured at the last week of the experiment.

Table 1. Ingredients and composition of the experimental diets

ME,CP		**2720, 15**		**2580, 14.25**
Enzyme (g/100) g)	0.00	0.90	0.00	0.90
Feed ingredients		**g / 100 g diet**		
Wheat	72.78	72.56	75.08	75.08
Fish meal	4.00	4.00	4.00	4.00
Soybean meal	7.53	7.59	5.51	5.51
Tomato pomace	3.00	3.00	3.00	3.00
Oil	1.95	2.02	0.00	0.00
Enzyme	0.00	0.90	0.00	0.90
Dicalcium phosphate	1.66	1.66	1.69	1.69
Limestone	8.15	8.15	8.15	8.15
Common salt	0.16	0.16	0.16	0.16
Vit & Min Premix[1]	0.50	0.50	0.50	0.50
Sand	0.00	0.00	1.76	1.67
DL-Methionine	0.16	0.16	0.17	0.17
Lys	0.11	0.11	0.00	0.00
Analysis results				
ME (Kcal/kg)	2720	2720	2580	2580
Crude protein (%)	15	15	14.25	14.25
Calcium (%)	3.67	3.67	3.67	3.67
Available P (%)	0.33	0.33	0.33	0.33
Lys (%)	0.64	0.71	0.58	0.58
Met (%)	0.38	0.38	0.38	0.38
Met & Cys (%)	0.62	0.62	0.61	0.61

[1]Vitamin mixture provides per 2.5 kilogram of diet: vitamin A, 7700,000 IU; vitamin D3, 3300,000 IU; vitamin E, 6,600 mg; vitamin K3, 550 mg; thiamine, 2200 mg; riboflavin, 4400 mg; vitamin B6, 4400 mg; Capantothenate, 550 mg; nicotinic acid, 200 mg; folic acid, 110 mg; choline chloride, 275,000 mg; biotin, 55 mg; vitamin B12, 8.8 mg.Mineral mixture provides per 2.5 kilogram of diet: Mn, 66000 mg; Zn, 66000 mg; Fe, 33000 mg; Cu, 8800 mg; Se, 300 mg; I, 900 mg

2.2 Statistical Analysis

Data of the 2×2 factorial arrangement of treatment were analyzed based on a completely randomized design using GLM procedure of SAS [10]. All statements of significance are based a probability of less than 0.05. The mean values were compared by Duncan's Multiple Range Test. The statistical model used in this investigation was $Y_{ijk} = \mu + A_i + B_j + (A.B)_{ij} + e_{ijk}$, where Y_{ijk} = tested parameter of laying hens fed diets; Ai =dietary inclusion of ME and CP (11.39,15 and 10.80,14.25 MJ/kg and percentage); Bj= dietary inclusion of endo-xylanase (0 and 0.9 g/kg) and (A.B)ij= interaction between ME and CP and endo-xylanase addition and eijkl = random error term.

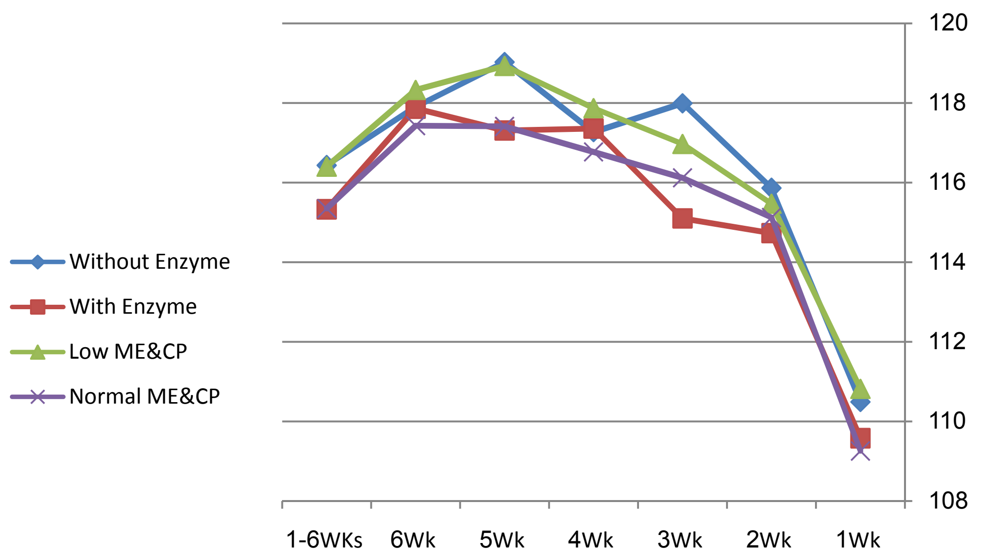
3. RESULTS AND DISCUSSION

Based on the results of the present study, effects of reducing CP & ME level and enzyme supplementation on feed intake, average egg weight, egg production, feed conversion ratio and egg mass during experimental period (6 weeks) are presented in Graghs 1, 2, 3, 4 and 5, respectively. There was no significantly difference between treatments on any of productive performance. Almost, diet supplementation by enzyme improved FCR of the laying hens Graph 4.

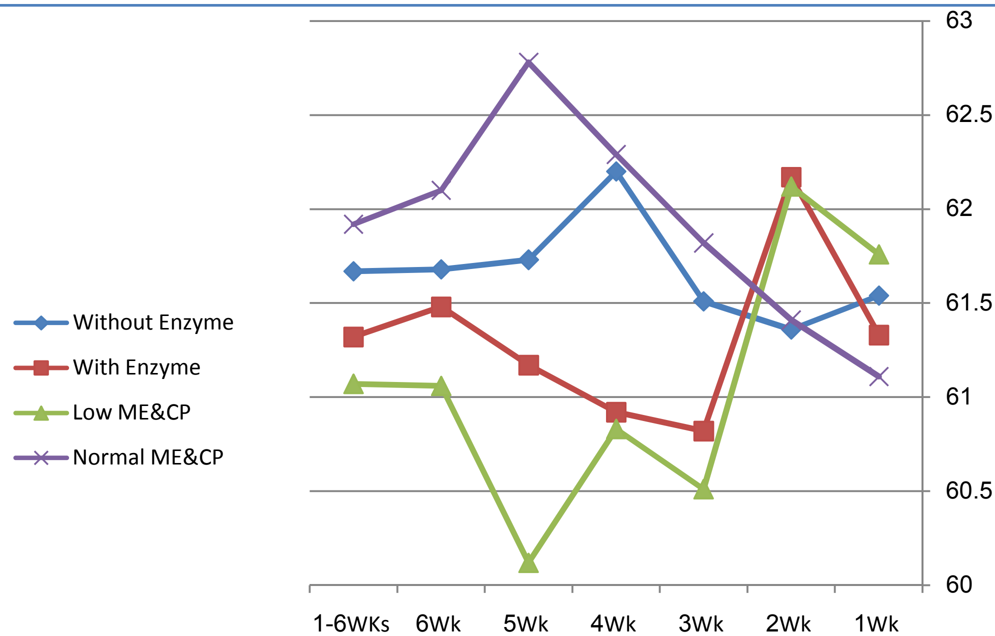
Bedford [11] stated that enzyme supplementation of diets formulated based on laying hens' requirements would not act efficiently. Novak et al. [12] observed greater energy retention (kcal/bird/day) for birds subjected to diets with reduced energy level and supplemented by enzyme complex (amylase + protease + xylanase) during the growth period (10 to 15 weeks). Cowieson et al. [13], who worked on reduced energy diets supplemented by enzyme complex (xylanase + protease + amylase + phytase) in broilers observed increased digestible dry matter, nitrogen, energy as compared to those fed the control diet with no enzyme. Rutherfurd et al. [14] indicated that phytase supplementation of diets caused increased retention of minerals and improved the digestibility of amino acids, lipids and carbohydrates. Choct [15] verified that the exogenous enzymes improve the digestibility of the dry matter by 0.17, apparent metabolizable energy by 0.24 and feed conversion by 0.31.

Based on the results of the present experiment, adding enzyme and reducing CP and ME level of a wheat based diet did not significantly affect egg quality characteristics, except egg shell weight and Haugh unit Table 2. Reducing CP and ME of diet decreased Haugh unit. Penz and Jensen [16] also observed a similar reduction in albumen percentage when reduced dietary CP from 16 to 13%. It has been reported that hens increase mRNA when fed by a reduced- CP diet [17]. Egg yolk components are produced in the liver and continuously accumulated in the ovum until ovulation, and may not be affected by reducing dietary CP [18].

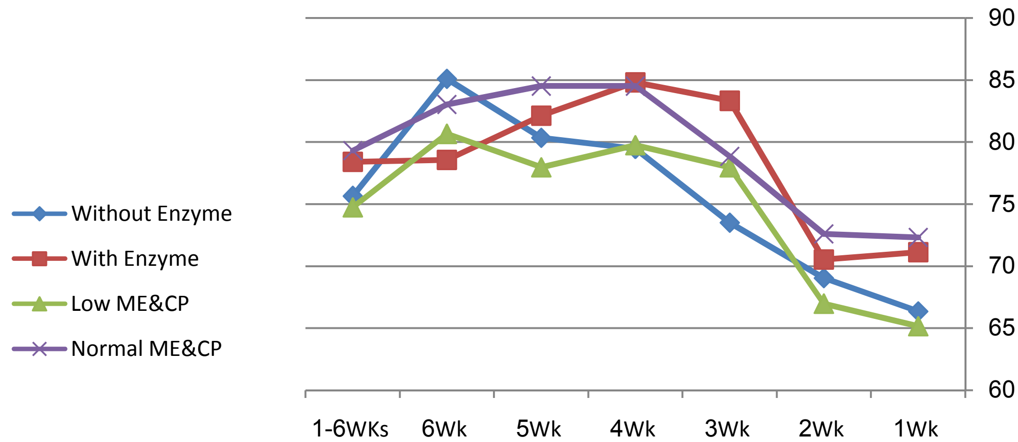
The weight of egg shell of the hens fed diet supplemented by enzyme significantly increased as compared to control. Bertechini [19], showed the importance of minerals in the nutrition of layers. Zanella [20] commented that exogenous enzymes reduces the endogenous production of amylase by 23.4% and pancreatic trypsin by 35.8%, which could favor protein synthesis in the muscle tissue because of the greater availability of the amino acids caused by this economy [21]. The plasma proteins, formed especially in the liver cells, can be degraded in amino acids by the cells of the mononuclear phagocytic system and made availabile to form cell protein, especially when the supply of amino acids from the digestive processes is not sufficient for the animal [22]. The results herein presented validate the information given by Reece [22], who showed the increased content of plasma proteins after enzyme supplement, demonstrating that this practice promotes an increase in the availability of amino acids present in the feed.



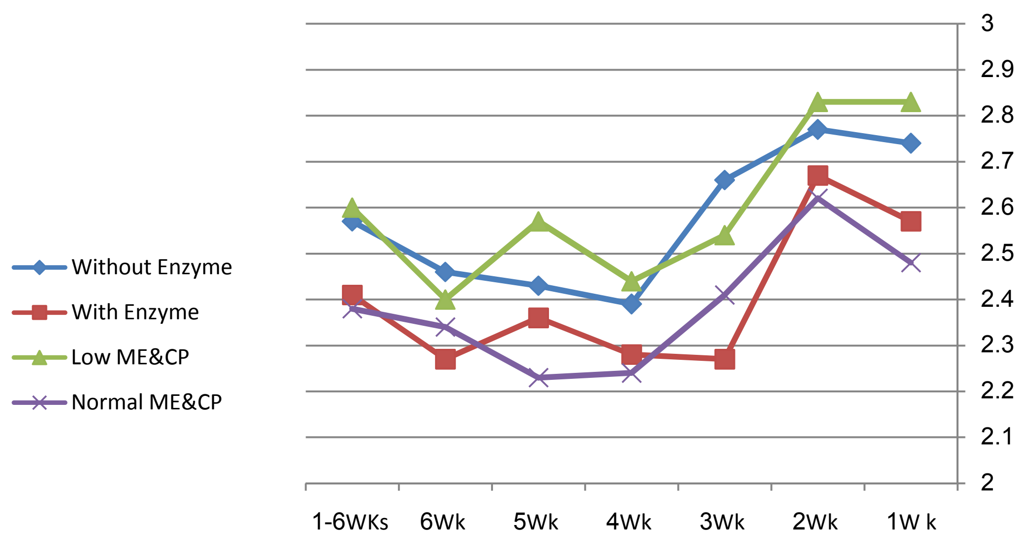
Graph 1: Effects of dietary energy and protein level (11.39, 15 and 10.80, 14.25) and enzyme supplementation (0.0 and 0.9 g/ kg) on feed intake of laying hens.



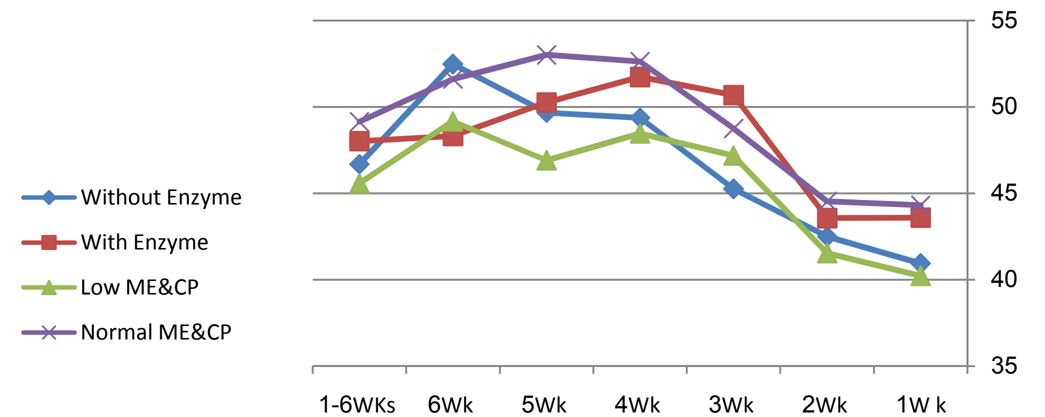
Graph 2. Effects of dietary energy and protein level (11.39, 15 and 10.80, 14.25) and enzyme supplementation (0.0 and 0.9 g /kg) on average egg weight of laying hens.



Graph 3. Effects of dietary energy and protein level (11.39, 15 and 10.80, 14.25) and enzyme supplementation (0.0 and 0.9 g/ kg) on egg production of laying hens.



Graph 4:Effects of dietary energy and protein level (11.39, 15 and 10.80, 14.25) and enzyme supplementation (0.0 and 0.9 g/ kg) on Feed conversion ratio (FCR) of laying hens.



Graph 5: Effects of dietary energy and protein level (11.39, 15 and 10.80, 14.25) and enzyme supplementation (0.0 and 0.9 g/ kg) on egg mass.

Table 2. Effects of dietary energy and protein level (11.39, 15 and 10.80, 14.25) and enzyme supplementation (0.0 and 0.9 g/ kg) on egg quality characteristics (egg index, yolk index, Haugh unit, egg shell weight and egg shell thickness)

Treatment	Egg quality characteristics				
	Egg index	Yolk index	Haugh unit	Egg shell weight(g)	Egg shell thickness(μm)
Enzyme					
0.0	75.38	41.22	63.19	6.46[b]	38.0
0.9	73.85	41.45	65.76	7.15[a]	39.5
ME & CP					
Low	74.32	41.96	61.52[b]	6.86	39.87
Normal	74.92	40.71	67.44[a]	6.75	37.63
SEM	0.91	0.67	1.35	0.16	1.18
CV	2.44	3.24	4.18	4.62	6.12
Source of variation	**Probability**				
ME & CP	0.519	0.086	0.0009	0.498	0.082
Enzyme	0.119	0.739	0.080	0.0008	0.229
ME & CP × Enzyme	0.298	0.701	0.460	0.217	0.165

a-b Means within a column (within main effects) with no common superscript differ significantly (P <0.05), SEM= Standard error of means

4. CONCLUSION

From the results of the present experiment it can be concluded that dietary enzyme supplementation can improve FCR of laying hens fed diets with reduced level of dietary energy and protein.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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