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Egg Quality, Component Yield And Composition Responses To Different Levels Of Dietary Digestible Lysine In Laying Hen

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Abstract

An experiment was conducted to evaluate the effects of different levels of digestible lysine on egg quality, component yield and composition during 32 to 44 week of age. A completely randomized block design was performed with five treatments and six replicate of eight Hy-line W-36 hens each. The experimental treatments were included five levels of digestible lysine (0.657, 0.707, 0.757, 0.807 and 0.857 % of diet). Blocks did not have any significant effect on all measured parameters in experimental period. Significant improvements in egg weight and haugh unit were observed by an increase in lysine intake. An increase in digestible lysine intake from 612 to 765 was significantly enhanced egg weight from 59.23 to 61.23 g. Haugh unit was significantly improved from 84.97 to 90.87 with in an increment in digestible lysine consumption from 612 to 724. An increase in digestible lysine intakes did not have any significant impact on percentage of egg components, specific gravity, eggshell thickness, dry matter and protein constituents of eggs. Based on the broken-line regression analysis, the digestible lysine requirement for optimal egg mass and haugh unit were 779 and 802 (mg/b/d), respectively.

Keywords: Digestible Lysine, Egg quality, Dry matter, Protein, Haugh unit.

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Introduction

Layer flock production dedicated to meet processor needs due to increasing numbers of liquid egg (LE) processing plants. Research into nutritional effects on LE yield and composition may provides the egg producer an effective management tool for customized shell egg production (EP) specifically managed to maximize the yield of liquid egg product (LEP). Liquid egg product is pasteurized and sold as either whole egg, albumen, yolk, or a specified blend Consumption of LE has expanded through retail consumer products and LEP utilization in hotel, restaurant, and institutional services. Standard parameters by which LEP are evaluated and marketed include percentage yolk and albumen solids. Percentage solids, commonly referred to as total or dried solids. In LEP, minimum solids content may be specified by a processor, customer, or regulatory agency. A second parameter of major importance to LE production is component yield including, albumen, yolk, and shell. Albumen and yolk are the valued products, whereas shell is treated as a low value by-product, or wastage, by breaking operations. Increasing proportional liquid component yield will allow processors to produce greater liquid mass from an equivalent number of eggs [1]. Gardner and Young (1972) [2] observed that increasing dietary protein from 12 to 18% significantly increased in the weights, solids, and protein content of yolk and albumen. Higher levels of dietary protein elicit higher protein concentrations in yolk and albumen (Andersson, 1979) [3].

Some striking observations were illustrated dietary protein and individual amino acids consumption rate can directly alter Dry matter and protein constituents of egg. However, the efficacy of amino acids in manipulating of protein contents of egg was rarely studied [4-6]. Generally, an estimation of amino acids requirements depends on, what production parameter taken into consideration for optimization [7]. The purpose of this experiment was to study the effects of different levels of digestible lysine on egg quality and dry matter and protein content of laying hen during 32 to 44 wk of age.

Materials and Methods

This experiment was performed on the base of comprehensive guide of animal welfare adopted in Ferdowsi University of Mashhad, (Mashhad, Iran). Two hundred-forty laying hens, Hy-Line W-36 with 85% of egg production were used during 32-44 wk of age. The experiment was planned in a complete randomized block design with five treatments and six replicates of eight birds each. Feed and water were provided ad libitum. The house temperature was in the range of 16 to 18 °C and the lighting program was set as 16L: 8D throughout the experiment. The diets were formulated to meet or exceed "Hy-line W-36" recommendations [13] for peak of egg production, except for digestible lysine. The experimental mash diets contained five levels of digestible lysine including 0.657, 0.707, 0.757, 0.807 and 0.857 % (Table 1). Protein and digestible amino acids of the feedstuffs, were analyzed by Evonik Degussa Co (with the use of NIR). Experimental periods were consisted of a 2 wk equilibration phase and 12 wk of data collection that divided into three consecutive periods of 28 d. digital Caliper (0.01 mm) and egg index was calculated by the following formula:

[(Egg width (mm) /egg length (mm)) ×100].

After weighing individual eggs by digital weighing (0.001-g), the egg components including, yolk and albumen were separated by commercially hand held egg separator and measured. Paper napkins was used to eliminate the adhering of albumin residues from yolks, and then yolks were weighed. The egg shells were washed by water and dried for 48 h followed by weighing and determining the egg shell thickness. Egg shell thickness was measured using micrometer apparatus (0.001-mm) at 3 disparate sites (top, middle, and bottom of the egg) and these measurements were averaged to calculate overall egg shell thickness. The albumen weight was calculated by subtracting the weight of yolk and shell, from whole egg weight [11]. Haugh unit was calculated based on the following formula [14]:

Haugh units =100×log [albumen height (mm) + 7.57− (1.7×egg weight (g) 0.037].

These qualitative measurements were done in less than 6 h after the egg collection. To measure DM and egg protein in the last day of the experiment, two eggs were collected randomly from each experimental unit. The egg yolk and albumen were attentively separated by commercially egg separator and after mixing and homogenization of yolk or albumen, five to six g of each sample was placed into aluminum dishes in an oven at temperature of 105 degree for 24 h. Samples were removed from the oven, placed into the desiccator and weighed immediately [19, 20]. Crude protein was analyzed using the SD-Kjeldahl Method [15].

All collected data were analyzed for normality using SAS software through Univariate plot normal procedure. Then, they were analyzed through GLM procedure with the help of Tukey test. Investigation of quadratic equation was performed by using the REG procedure [16], and the lysine requirement for optimal production was determined using NLIN procedure, through the method described by Robbins et al. [17].

Result and discussion

The effect of different levels of digestible lysine on egg weight is shown in Table 1. An increase in digestible lysine consumption from 612 to 765 (mg/b/d) significantly enhanced egg weight from 59.22 to 61.42 (g). Requirements of digestible lysine were estimated to be 779 (mg/b/d) in order to obtain best response of egg weight. The results were in agreement with findings of Applegate et al. [18], Bregendahl et al.[19], Neto et al. [20], Silva et al. [21], Nathanael and Sell [5], Schutte and Smink [3], Al Bustany and Elwinger [6], Novak et al. [12], and Prochaska et al. [9], whom reported a significant improvement in egg weight through lysine supplementation. Bregendahl et al. [19] reported the lysine requirement of 649 and 573 (mg/b/d) to culminate egg weight in Hy-line W-36 layers during 28 to 34 and 52 to 58 wk of age, respectively. Also Nathanael and Sell [5] estimated lysine requirement of 700 (mg/b/d) to obtain optimal egg weight of 56.87 g in Hy-line W-36 layers during 22 to 42 wk of age.

Albumen, yolk and eggshell percentage of egg were not affected by lysine supplementation during (Table 1). In agreement, Applegate et al. [18] reported that, the increase in lysine intake did not significantly affect egg component percentage. In contrast, Novak et al. [12] reported a significant effect on percentage of albumin and yolk in response to supplemental lysine in DeKalb delta layers during 20 to 63 wk of age. In the current study, the average of digestible

Table 1: Effects of dietary digestible lysine intake on egg qualitative traits

Digestible lysine intake (mg/b/d)	Egg weight (g)	Albumin (%)	Yolk (%)	Shell (%)
612	59.23^{b}	64.23	26.10	9.67
676	60.50^{ab}	64.25	26.21	9.54
765	61.42^{a}	63.84	26.50	9.67
824	62.03^{a}	64.34	26.13	9.54
864	61.37^{ab}	64.23	26.44	9.34
SEM	0.645	0.470	0.317	0.240
P-values	0.0402	0.7208	0.6002	0.4732
Quadratic *P*-values	0.0110	0.6935	0.6684	0.2652
Estimated requirement (mg/b/d)	779	-	-	-

a–d Values with uncommon superscripts within each column are significantly different ($p < 0.05$).
1Data are means of six replications of nine eggs each.

lysine intake was 748 (mg/b/d), but in the experiment of Novak et al. [12] the average of lysine intake was 909 (mg/b/d). Prochaska et al. [9] performed two distinct experiments with differences in dietary lysine levels and age of hens and stated disparate results. In the first experiment that was carried out with Hy-line W-36 layers the percentage of yolk and albumin were not affected with the lysine intakes changes from 638 to 1165 (mg/b/d). In the second experiment, the percentage of yolk and albumin significantly affected when lysine intake changed from 677 to 1613 (mg/b/d) during 42 to 64 wk of age. An explanation for these inconsistent results described by the differences in lysine and other nutrient intakes between the two studies.

The effect of digestible lysine consumption on egg index, haugh unit, specific gravity and eggshell thickness are shown in Table 2. An increase in digestible lysine consumption from 612 to 824 (mg/b/d), resulted in significant augmentation of haugh unit from 84.96 to 90.87. The response of haugh unit to lysine intakes were produced quadratically related. The results of broken-line regression showed the requirement of digestible lysine to achieve optimal haugh unit was 802 (mg/b/d).

Egg index, specific gravity and eggshell thickness were not affected by lysine supplementation during experimental period.

Table 2: Effects of dietary digestible lysine intake on egg qualitative traits [1]

Digestible lysine intake (mg/b/d)	Egg index (%)	Haugh unit	Specific gravity (g/cm3)	Shell thickness (mm)
612	77.17	84.97 [c]	1.082	0.379
676	78.20	87.05 [b]	1.083	0.377
765	77.57	88.43[b]	1.082	0.385
824	76.76	90.87[a]	1.081	0.377
864	76.63	90.28[ab]	1.080	0.381
SEM	0.808	0.675	0.001	0.004
P-values	0.0892	0.0001	0.3957	0.6029
Quadratic *P*-values	0.6325	0.034	0.1484	0.8411
Estimated requirement (mg/b/d)	-	802	-	-

a–d Values with uncommon superscripts within each column are significantly different ($p < 0.05$).
[1]Data are means of six replications of nine eggs each.

Dry matter and protein contents of yolk, albumen and the whole egg liquid were not affected by digestible lysine intake (Table 3). These observations were in agreement with Applegate et al. [8] but inconsistent with Prochaska et al. [4] and Novak et al. [7]. In experiment of Novak et al. [7] with 909 (mg/b/d) average of lysine intake, found a significant effect on protein contents of yolk and albumin but not on DM of yolk, albumin and the whole egg. Prochaska et al. [4] conducted two trials with variety of dietary lysine levels and age of hens and revealed different results. In the first experiment that was performed with Hy-line W-36 layers, lysine intake of 638, 828, 1062 and 1165 (mg/b/d), significantly affected DM and protein contents of yolk and albumin during 23 to 38 wk of age. In the second experiment, lysine intake of 677, 1154 and 1613 (mg/b/d) significantly affected DM and protein contents of albumin during 42 to 64 wk of age but neither dry matter of yolk nor protein changed. The main reason for this inconsistency may be due to discrepancy in lysine intake. Modification in DM and protein contents of egg were expected by over consumption of lysine than real requirement of birds. Seemingly by increasing lysine concentration to its competitors in absorption, lysine is taken up in larger proportion. In addition, by elevating concentration of amino acid in plasma, insulin secretion will increase by pancreas. Two functions of insulin include increasing amino acid uptake and protein synthesis [4].

Table 3: Effects of digestible lysine intake on egg DM and protein content [1]

Digestible lysine intake (mg/b/d)	Yolk		Albumin		Total egg (without shell)	
	DM (%)	Protein[2]	DM (%)	Protein[2]	DM (%)	Protein[2]
612	51.19	16.65	11.62	10.35	20.85	11.52
676	51.09	16.92	11.71	10.88	20.51	11.87
765	51.28	16.99	12.50	11.10	20.61	11.93
824	51.34	17.12	12.34	11.41	21.34	12.01
864	51.49	17.33	12.41	11.55	21.38	12.18
SEM	0.209	0.265	0.143	0.133	0.130	0.138
***P*-values**	0.1282	0.3812	0.1985	0.1651	0.1208	0.1891
Quadratic *P*-values	0.4581	0.5125	0.3359	0.2401	0.4536	0.3412
Estimated requirement (mg/b/d)	-	-	-	-	-	-

[1]Data are means of six replications of 2 eggs each at 44 wk of age.

[2] Protein in 100 g of egg DM.

Conclusion

In conclusion, the digestible lysine requirements to obtain best egg weight and haugh unit 779 and 802 (mg/b/d), respectively for Hy-line W-36 layers during 32 to 44 wk of age. The observation from this experiment demonstrated the lysine intakes in the range of 612 to 764 (mg/b/d) did not have any effect on dry matter and protein constituent of egg. Based on the broken-line regression analysis, the digestible lysine requirement for optimal egg mass and haugh unit were 779 and 802 (mg/b/d), respectively.

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