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

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Abstract
A total of 240 Hy-line W-36 hens were allocated to five treatments and six replicates of eight each to evaluate the effects of different levels of digestible sulfur amino acid **(DSAA)** on egg quality, component yield and composition during 32 to 44 week of age. This experiment was conducted in a completely randomized block design. The treatments were included five levels of DSAA as 5.1, 5.6, 6.1, 6.6 and 7.1 (g / kg). Blocks did not have any significant effect on all measured parameters. An increase in DSAA intake from 496 to 672 (mg/b/d) significantly enhanced egg weight from 57.97 to 62.55 g. An increase in DSAA intake did not have a significant effect on haugh unit, percentage of egg components, specific gravity, eggshell thickness, dry matter and protein constituents of eggs. Although, haugh unit was quadratically related to dietary DSAA. Based on the broken-line regression analysis, the DSAA requirement for optimal egg weight and haugh unit were 653 and 693 (mg/b/d), respectively.

Keywords: Digestible sulfur amino acid, Egg quality, Egg components yield, Egg protein.

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Introduction

Chickens and other egg-laying creatures are widely use throughout the world. In 2009, an estimated 62.1 million tons of eggs were produced worldwide from a total laying flock of approximately 6.4 billion hens. Chicken eggs supply all essential amino acids for humans (a source of complete protein). One factor considers as an indicator of egg quality, is egg solids. Over the past four decades, an increasing percentage of total egg production has been used in the form of processed eggs. Processed egg consumption has steadily increased from 31 eggs per capita in1975 to 56 in 1993 (USDA, 1994). The liquid egg product (LEP) is egg production broken out of the shell and marketed as whole egg, separate albumen or yolk, or a specific mixture. Percentage solids, an important quality measure, primarily determines the commercial value of liquid yolk and albumen. The functional properties of eggs are correlated to the primary components of egg solids, including protein, lipoprotein, lipid, and a small percent of carbohydrates, and their interactions with other ingredients in food products [1]. Calvery and Titus (1934) [2] observed differences in egg weight, size, albumen and yolk yield, solids, and protein composition of eggs produced by hens fed diets differing in wheat, corn, or soybean meal. They also recorded differences in amino acid composition and total nitrogen content of the eggs. Butts and Cunningham (1972) [3] reported that total nitrogen in whole egg and albumen increased as dietary protein increased from 12 to 18%. Egg yolk and albumen DM and protein contents are modified in response to dietary amino acids and protein [4]. In experiment of Shafer *et al*. [5] with an increment of methionine intake from 413 to 556 (mg/b/d), egg weight, albumen and yolk weight, DM, albumen and yolk protein were increased and their findings were in agreement with their previous study [4]. In general, estimation of amino acids requirements depends on, what production parameter is taken into consideration for optimization. The aim of this experiment was to evaluate the effects of different levels of digestible sulfur amino acids (DSAA) on egg component yield and composition of laying hens during 32 to 44 wk of age.

Materials and Methods

This Experiment was conducted 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 which had equal conditions at 0.85 of egg production (egg /hen d) were used during the 32 to 44 wk of age. All birds had free access to drinking water and feed. During the experiment, the house temperature was in the range of 16 to 18 °C and the lighting program was performed as 16L: 8D. Weight of the hens from each unit were measured individually at the beginning and the end of experiment. The experimental diets were formulated based on the recommendations of Hy line layers (W-36) for peak of egg production, with the exception of DSAA. The experiment conducted in a complete randomized block design, with five treatments, six replicates of eight birds each. The experimental treatments comprised of mash diets contained five levels of 5.1, 5.6, 6.1, 6.6 and 7.1 (g / kg) of the DSAA. (Table 1). Protein, amino acids, and digestible amino acids of feed ingredients were analyzed by Evonik Degussa Co. (using NIR). Experimental period were included a 2 wk equilibration phase followed by 12 wk of data collection, that divided into three consecutive of 28-d periods. Three eggs were randomly picked up from each experimental units in three consecutive days at the end of each period in order to assess egg quality. Eggs width and length were measured by digital Caliper (0.01 mm, Digital caliper, model 1116-150 Insize Co, Suzhou, China). Egg index was computed by the following formula:

(Egg width (mm) /egg length (mm)) ×100

After weighing individual egg by digital weighing (0.001-g, Digital balance, model GF 400, A&D Weighing, CA, USA) , the Shafer et al. (1998) [5] described method was used to characterize the egg components. Egg yolk and albumen were separated by commercially hand held egg separator. With the use of paper napkins adhering albumin was removed from the yolk and then yolk was weighed. The eggs shell were washed by water and dried for 48 hours followed by weighing and measuring egg shell thickness. Eggshell thickness was measured at 3 different locations (top, middle, and bottom of the egg) using micrometer apparatus (0.001-mm, Digital micrometer, model 293-240, Mitutoyo Co, Kanagawa, Japan) and average of 3 measurements, was calculated as overall egg shell thickness. Albumen weight was calculated by subtracting the yolk and eggshell weight, from whole egg weight. Haugh unit was computed based on the following formula (Gunawardana et al., 2009):

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 assess DM and egg protein in the last day of the experiment, two eggs were collected randomly from each experimental units. The egg yolk and albumen were separated by commercially egg separator and after mixing and homogenization of yolk and albumen, 5 to 6 g of each sample was placed into aluminum dishes in an oven at temperature of 105 degree for 24 h. Samples were placed in desiccator after removal from the oven and were weighed immediately [7 ,6]. Crude protein was also generated using the SD-Kjeldahl Method [8].

All data were analyzed for normality using SAS software through Univariate plot normal procedure. Then, they were subjected to SAS software and analyzed through GLM procedure with Tukey test. The probability of a quadratic equation was considered by the REG procedure. And, if it was significant, the DSAA requirement for optimal production was estimated using NLIN procedure, through the method described by Robbins et al. [9]

Result and discussion

There were no significant differences among the blocks in any of the considered parameters.

Egg weight was significantly affected by DSAA consumption (Table 1). Egg weight was significantly improved from 57.97 to 62.55 g with an increase in DSAA intake from 496 to 672 (mg/b/d). The daily requirement of DSAA to achieve optimal egg weight was 653 (mg/b/d). Egg weight in the numerous studies conducted in the first or second laying cycle was affected by the various levels of dietary sulfur amino acids [16-10 ,5 ,4]. Solarte et al., (2005) [14] stated the requirement of 681 (mg/b/d) for methionine + cystine in Lohman hens at the average egg weight of 58.61 g. This amount is almost 4% higher compared to the estimated DSAA requirement in our experiment (653 mg/b/d) for the average of egg weight 60.97 g.

Albumen, yolk and shell yield of egg were not affected by DSAA intakes (Table 2). This results are similar to other reports [11 ,5 ,4]. However, Bunchasak and Silapasorn (2005) [12] observed significant changes in the percentage of albumen and yolk in hens during 24 to 44 wk of age. Yolk yield was reduced from 25.01 to 23.76 (g /100 g egg) and albumen significantly increased from 64.95 to 66.19 (g /100 g egg) by an increase in methionine intake from 228 to 294 (mg/b/d). One possible reason for this inconsistent results may be due to the differences in the basal diets, because they used low protein diets with 140 (g/kg) protein. But in their experiment, the percentage of albumen and yolk did not change when hens fed diet contained 160 (g/kg) protein. Accordingly, it can be concluded that the amount of albumen and yolk for hens fed low protein diet were affected by the TSAA consumption [17].

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

Digestible DSAA intake (mg/b/d)	Egg weight (g)	Albumin (%)	Yolk (%)	Shell (%)
496	57.97[b]	64.42	25.97	9.65
549	60.14[b]	64.16	26.25	9.58
611	61.37[ab]	64.54	26.02	9.44
672	62.55[a]	64.44	26.04	9.52
723	62.23[ab]	64.22	26.24	9.54
SEM	0.739	0.417	0.495	0.283
P-values	0.0311	0.9616	0.9629	0.9597
Quadratic *P*-values	0.0004	0.6539	0.4668	0.7698
Estimated requirement (mg/b/d)	653	-	-	-

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.

Egg index, haugh unit, specific gravity and shell thickness were not affected by the DSAA intakes (Table 2). Solarte et al. (2005) [14] reported haugh unit was significantly improved by an increase in the DSAA consumption from 444 to 630 (mg/b/d), in Lohman hens during 22 to 38 wk of age. Their result contradicted with our findings, which may be due to the use of diets with very low sulfur amino acids in their trial compared to our experiment. The haugh unit was quadratically related to dietary DSAA level. The DSAA requirement to achieve the optimal

Haugh unit was 693 in the whole experimental period (mg/b/d).

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

Digestible DSAA intake (mg/b/d)	Egg index (%)	Haugh unit	Specific gravity (g/cm3)	Shell thickness (mm)
496	77.26	86.82	1.082	0.380
549	77.43	88.42	1.084	0.380
611	77.75	88.78	1.080	0.380
672	76.64	89.64	1.084	0.378
723	77.1	89.14	1.084	0.380
SEM	0.562	1.762	0.002	0.002
P-values	0.2471	0.1070	0.6578	0.4362
Quadratic *P*-values	0.3679	0.0420	0.1184	0.1184
Estimated requirement (mg/b/d)	-	693	-	-

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.

The effects of different levels of dietary DSAA in dry matter and egg protein content are shown in Table 3.

Table 3: Effects of digestible DSAA intake on egg dry matter and protein content [1]

Digestible DSAA intake (mg/b/d)	Yolk		Albumin		Total egg (without shell)	
	DM (%)	Protein[2]	DM (%)	Protein[2]	DM (%)	Protein[2]
496	51.29	16.85	11.42	10.07	20.68	10.86
549	51.00	17.15	11.50	10.45	20.47	11.14
611	51.39	16.95	11.74	10.60	20.94	11.25
672	51.84	17.02	12.54	11.70	21.61	11.96
723	51.84	17.01	12.82	11.65	21.63	11.95
SEM	0.602	0.253	0.641	0.922	0.665	0.623
***P*-values**	0.2283	0.5802	0.1231	0.1598	0.1842	0.1201
Quadratic *P*-values	0.2121	0. 8856	0.4129	0.1159	0.2163	0.5321
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.

The dry matter and protein content of yolk, albumen and the whole egg were not affected by the DSAA intake in the whole experimental period. Our observations contradicted the findings of Shafer et al. (1998) [5]. The main reason for this inconsistency may be due to the differences in methionine intakes. In the study of Shafer et al. (1998) [5], the experimental diets consisted of high concentrations of methionine, so that, the amount of daily methionine consumption ranged from 413 to 556 (mg/b/d). But in our study, the digestible methionine intake ranged from 300 to 420 (mg/b/d).

Conclusion

Our observation elucidated, an increase in DSAA intakes from 496 to 672 could improve egg weight. However, DSAA intake in the range of 496 to 723 could not modify haugh unit, egg component yields and composition. Based on broken-line regression analysis, the digestible DSAA requirement for optimal egg weight and haugh unit were 653 and 693 (mg/b/d), respectively.

References

1. Prochaska, J. F., J. Carey, and D. Shafer. 1996. The effect of L-lysine intake on egg component yield and composition in laying hens. Poultry Science 75:1268-1277.

2. Calvery, H. O., and H. W. Titus. 1934. The composition of the proteins of eggs from hens on different diets. Journal of Biological Chemistry 105:683-689.

3. Butts, J., and F. Cunningham. 1972. Effect of dietary protein on selected properties of the egg. Poultry Science 51:1726-1734.

4. Shafer, D., J. Carey, and J. Prochaska. 1996. Effect of dietary methionine intake on egg component yield and composition. Poultry Science 75:1080-1085.

5. SHAFER, D. J., J. B. CAREY, J. F. PROCHASKA, and A. R. SAMS. 1998. Dietary Methionine Intake Effects on Egg Component Yield, Composition,Functionality, and Texture Profile Analysis. Poultry Science 77:1056–1062.

6. Li, F., L. M. Zhang, X. H. Wu, C. Y. Li, X. J. Yang, Y. Dong, A. Lemme, J. C. Han, and J. H. Yao. 2013. Effects of metabolizable energy and balanced protein on egg production, quality,and components of Lohmann Brown laying hens. Applied Poullry Science 22:36–46.

7. Wu, G., M. Bryant, R. Voitle, and D. Roland. 2005. Effect of dietary energy on performance and egg composition of Bovans White and Dekalb White hens during phase I. Poultry science 84:1610-1615.

8. AOAC, W. H. 1990. Official methods of analysis of the Association of Official Analytical Chemists. Association of Official Analytical Chemists, Arlington, VA, USA.

9. Robbins, K. R., A. M. Saxton, and L. L. Southern. 2006. Estimation of nutrient requirements using broken-line regression analysis. Journal of animal science 84:155-165.

10. Harms, R. H., and G. B. Russell. 1996. A Re-evaluation of the Methionine Requirement of the Commercial Layer. Journal of Applied Animal Research 9:141-151.

11. Gomez, S., and M. Angeles. 2009. Effect of threonine and methionine levels in the diet of laying hens in the second cycle of production. Applied Poullry Science 18:452–457.

12. Bunchasak, C., and T. Silapasorn. 2005. Effects of adding methionine in low-protein diet on production performance, reproductive organs and chemical liver composition of laying hens under tropical conditions. International Journal of Poultry Science 4:301-308.

13. Waldroup, P., and H. Hellwig. 1995. Methionine and total sulfur amino acid requirements influenced by stage of production. The Journal of Applied Poultry Research 4:283-292.

14. Solarte, W. N., H. S. Rostagno, P. R. Soares, M. A. Silva, and L. F. U. Velasquez. 2005. Nutritional Requirements in Methionine + Cystine for White-Egg Laying Hens During the First Cycle of Production. Poultry Science 18:965-968.

15. Schutte, J. v., and E. Van Weerden. 1978. Requirement of the hen for sulphur- containing amino acids. British poultry science 19:573-581.

16. Schutte, J., J. De Jong, and H. Bertram. 1994. Requirement of the laying hen for sulfur amino acids. Poultry Science 73:274-280.

17. Novak, C., H. M. Yakout, and S. E. Scheideler. 2006. The Effect of Dietary Protein Level and Total Sulfur Amino Acid:Lysine Ratio on Egg Production Parameters and Egg Yield in Hy-Line W-98 Hens. Poultry Science 85:2195–2206.