Effect of Digestible Essential Amino Acid in Low Protein Diets on Production Performances and Egg Quality of Laying Hens

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ABSTRACT

The objective of this study was to investigate the effect of digestible essential amino acids (DEAA) in low protein diets on production performances and egg quality of laying hens. The experiment was designed as a 2×3 factorial arrangement in CRD with 2 dietary protein levels (16.00 and 12.8% CP) and 3 dietary Standard Ileal Digestible Lysine Levels (SIDLL; 100, 110 and 120%) as recommended by NRC (1994) and INRA (2004), respectively. For methionine (Met), threonine (Thre) and tryptophan (Tryp) as related by Ideal Protein Concept (IPC) as suggested by NRC (1994) and INRA (2004). However, metabolizable energy (ME), calcium (Ca) and available phosphorous (avai P) of all experimental diets were close to the recommendation of NRC (1994). Two hundred and seventy Isa Brown Hens (28 weeks of age) were randomly allocated to 6 dietary treatments with 5 replications as comprised of 9 birds per replicate (3 hens/cage). Laying hens fed dietary treatments between 28 to 44 weeks of age and hen-day egg production (HD), feed intake (FI), egg weight (EW), weight gain (WG) as well as egg composition and egg quality were measured for production performances and egg quality. The results shown that dietary SIDLL had no adverse effect on HD, EW, egg mass (EM), feed cost per kilogram egg (FC) and survival rate (SR). However, HD, FI, EW and WG were significantly impared (P<0.05) with reduced crude protein level (12.8% CP). Feed conversion ratio (FCR) was significantly improved (P<0.05) when compared with high protein level (16% CP). The results also shown that dietary protein levels and dietary SIDLL have no adverse effect on percentage of eggyolk (PEY) eggshell (PES), eggyolk color (EYC), eggshell thickness (EST) and egg specific gravity (ESG), however when reduced dietary protein levels to 12.8% it has significantly reduced (P<0.05) percentage of egg albumen (PEA) and EW when compared with 16.0 crude protein level. It can be concluded that dietary formulation with 16.0% crude protein levels and formulated laying hen diets based on SIDLL was the optimum level to improve production performances and egg quality.

Key words: Digestible essential amino acid, Laying hen diets, Production performances, Egg quality

INTRODUCTION

It is known that monogastric animal like chickens do not have requirement for crude protein (CP) per Se but for amino-acids (AA), or more specially, for DEAA. Therefore, laying hens feed should be formulated to meet the DEAA requirements of chickens rather than CP and/or total amino acid (TAA), (Novak et al., 2006). As of today, feed grade L-Lysine, DL-Methionine, L-Threonine and L-Tryptophan are readily available. Thus, it is rather easy for least cost formulation (LCF) to meet the minimum spec of these four essential amino acid (EAA). Formulations of layers feed with DEAA without CP minimum usually lower the CP content of feed, which would reduce nitrogen excretion when compared the conventional feeds with CP minimum (Harms and Russell, 2003). The objective of this study was to evaluate the effect of digestible essential amino acids in low protein diets on production performances of laying hens.

MATERIALS AND METHODS

Two hundred and seventy Isa Brown hens (28 weeks of age) were randomly allocated to 6 treatment combinations with 5 replications as composed of 9 birds per replicate (3 hens/cage). The experiment was designed as 2×3 factorial arrangement in CRD with 2 dietary protein levels (16.0 and 12.8% CP) and 3 dietary Standard Ileal Digestible Lysine Levels (SIDLL, 100, 110 and 120%) as recommended by NRC (1994) and INRA(2004), respectively, for Met, Thre and Tryp as related by Ideal Protein Concept (IPC) as suggested by NRC (1994) and INRA (2004). However, ME, Ca and avai P of all experimental diets were close to the recommendation of NRC (1994) which diet formulation and nutrient composition were shown in Table 1. Laying hens fed dietary treatments between 28 to 44 weeks of age and HD and egg quality were measured for production performances and egg quality. Each pen was provided with nipple value drinker and feeder and birds were given *ad libitum* feeding and drinking water. The lighting program was 16L, 8D hour cycle throughout the trial, temperture controlled at 25°C. HD and EW were recorded daily and hens were weighted indivindually at the beginning and the and of trail. Average hen weight was calculated by replicate cage for weight gain in the entire trial period. FI was recorded weekly and FCR (g of feed/g of EM) was calculate by using the average FI per hen divided by grams of EM (HDX EW) produced. Biweekly, ESG were determined using the HD of 1 d and 2 egg per cage were used for EST, EYC and wet egg component (% shell, albumen and yolk) determination. All data were subjected to analysis of varience of GLM procedure as recommended by Khunthum (2006). Differences among treatment means were compared using the Duncan's new multiple range tests. Statistical significance was established at *P*<0.05.

Table 1. Ingredients and nutrient compositions of the experimental diets (%).

Ingredients	Experimental diets (treatments)					
	1	2	3	4	5	6
Corn	57.73	58.12	58.51	59.12	59.51	59.89
Rice bran, full fat	10.0	10.0	10.0	20.0	20.0	20.0
Soybean meal (44%CP)	15.89	15.41	14.94	5.40	4.92	4.44
Fish meal(55%CP)	5.0	5.0	5.0	4.50	4.50	4.50
Granular limestone	8.78	8.78	8.78	8.95	8.94	8.94
Dicalcium phosphate (Ca 21.75%; P18.5%)	0.12	0.12	0.12	0.08	0.09	0.10
Palm oil	1.33	1.20	1.06	0.36	0.2	0.09
NaCl	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix[1]	0.25	0.25	0.25	0.25	0.25	0.25
Mineral premix[2]	0.25	0.25	0.25	0.25	0.25	0.25
L-Lysine[3]	0.06	0.15	0.25	0.30	0.39	0.48
DL-Methionine[4]	0.18	0.22	0.27	0.21	0.25	0.31
L-Tryptophan[5]	0.03	0.05	0.07	0.07	0.09	0.12
L-Threonin[6]	0.03	0.10	0.15	0.16	0.23	0.28
Total (kg)	100	100	100	100	100	100
Total cost (baht/kg)	12.48	12.77	13.07	12.30	12.59	12.98

Table 1. Continued.

Ingredients	Experimental diets (treatments)					
	1	2	3	4	5	6
Calculated nutrient composition (% air dry basis)						
Crude protein	16.0	16.0	16.0	12.80	12.80	12.80
ME, kcal/kg feed	2850	2850	2850	2850	2850	2850
Ether extract	5.21	5.09	4.96	5.36	5.24	5.11
Crude fiber	3.53	3.51	3.48	3.92	3.90	3.87
Calcium	3.75	3.75	3.75	3.75	3.75	3.75
Available phosphorus	0.35	0.35	0.35	0.35	0.35	0.35
Total Lysine	0.91	0.99	1.08	0.91	0.98	1.06
Total Methionine	0.47	0.51	0.56	0.47	0.51	0.57
Total Tryptophan	0.21	0.23	0.24	0.20	0.22	0.25
Total Threonine	0.68	0.75	0.79	0.67	0.73	0.77
Digestible Lysine	0.81	0.89	0.97	0.81	0.89	0.97
Digestible Methionine	0.44	0.48	0.53	0.44	0.48	0.53
Digestible Tryptophan	0.18	0.20	0.22	0.18	0.20	0.22
Digestible Threonine	0.57	0.63	0.68	0.57	0.63	0.68

[1]Provide per kilogram of diet: vitamin A (as retinyl acetate), 8,000 IU; cholecalciferol 2,200 ICU; vitamin E (as DL-α tocopheryl acetage), 8 IU; vitamin B12, 0.02 mg; riboflavin, 5.5 mg; D-calcium pantothenic acid, 13 mg; niacin, 36 mg; choline, 500 mg; folic, 0.5 mg; vitamin B1 (thiamin mononitrate), 1 mg; pyridoxine hydrochloride, 2.2 mg; d-biotin, 0.05 mg; folic acid , 0.5 mg; vitamin B1 (thiamin mononitrate), 1 mg; pyridoxine hydrochloride, 2.2 mg; d-biotine, 0.05 mg; vitamin K (menadione sodium bisulfate complex), 2 mg

[2]Provide per kilogram of diet: manganes (manganous oxide), 65 mg; iodine (ethylene diamine dihydriodide), 1 mg; iron (ferrous carbonate), 55 mg; copper (copper oxide), 6 mg; zinc (zinc oxide), 55 mg; selenium (dodium selenite), 0.03 mg

[3]L-Lysine monohydrochloride 98.5% feed grade

[4]Degussa (Thailand) Co., Ltd.

[5,6]Ajinomoto (Thailand) Co., Ltd.

RESULTS AND DISCUSSION

The result of the effect of digestible essential amino acids (DEAA) in low protein diets on production performances and egg quality of laying hens are shown in Table 2 and 3, respectively. It was shown that the interaction between dietary standard Ileal digestible lysine levels (SIDLL) and low protein diets (LPD) was not significant for all traits studied; therefore, only the main effects are presented. It was found that HD, EW, EM, FC and SR were not affected by dietary SIDLL, however, HD, FI, EW, and EM were significantly impaired (P<0.05) with reduced crude protein levels (12.8%), however FCR was significantly improved (P<0.05) when compared with high protein levels (16% CP) as the result was shown in Table 2. These result have been agreed with the reports of Hsu et al. (1998); Jungueira et al. (2006) and Khajali et al. (2008) who have found that layer performances such as HD, FI, EW, EM and FC could be maintained well on formulations were based on SIDLL when diets were properly supplemented with essential amino acids. Whereas HD, FI, EW, EM, FC and WG were significantly impaired (P<0.05) when reduced crude protein levels to 12.80%. It may be due to that birds which received lower crude protein levels had significantly lower (P<0.05) body weight gains (WG) than those that received higher crude protein level (16.0% CP) as shown in Table 2. These result are supported by the reports of Dari et al. (2005) and Khajali et al. (2008) who have shown that when birds received lower crude protein diets will cause decreased body protein reserves and will affect on HD, FI, EW and EM. According to FC has significantly increased (P<0.05) when birds receive high dietary crude protein levels (16.0% CP) because with increased high crude protein levels, it will cause high feed prices as shown in Table 1. This result is supported by the reports of Dari et al. (2005) and Khajali et al. (2008) who is suggested that diet formulation on high crude protein level being more expensive due to a higher supplementation of feed ingredients which had high source of crude protein such as soybean meal and fish meal.

Table 2. The effect of dietary SIDLL and low protein diets on production performances of laying hens.

Dietary treatments	HD (%)	FI (g/b/d)	EW (g)	EM (b/b/d)	FCR	FC (bahts/kg)	SR	WG (g/b)
Dietary SIDLL (%)								
100	86.95	96.01	52.40	45.70	1.83	22.70	98.52	414.32
110	85.51	94.83	53.33	45.85	1.79	22.40	97.29	417.36
120	85.56	95.95	52.43	44.52	1.80	22.80	97.78	413.07
Dietary protein levels (%)[1]								
16.0	83.09[a]	91.04[a]	55.40[a]	43.52[a]	1.85[a]	23.67[a]	98.52	406.98[a]
12.8	79.98[b]	88.84[b]	51.99[b]	41.54[b]	1.71[b]	21.59[b]	97.29	387.12[b]
Main effects								
Dietary SIDLL[2]	NS	NS	NS	NS	NS	NS	NS	NS
Dietary protein levels	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	P<0.05	NS	P<0.05
Dietary SIDLL x Dietary protein levels[2]	NS	NS	NS	NS	NS	NS	NS	NS
SME[3]	1.827	2.078	0.39	1.01	0.047	0.416	1.472	32.10

[1]a,b Numbers with different superscripts differ statistically at P<0.05
[2]NS (non statistical differences)
[3]SEM (5 replicates of 45 hens each treatment)

According to egg quality, it was found that PEY, PES, EYC, EST and ESG were not affected by dietary SIDLL while EW and PEA significantly impaired (P<0.05) when reduced crude protein level to 12.80%. These results agree with the reports of Harms and Russell (2003), Novak et al. (2006) and Khajali et al. (2008) who have shown that there were no significant differences between egg quality when birds fed diets as used SIDLL which formulated by supplementation with synthetic essential amino acids, however it will affect on EW and PEA which significantly reduced (P<0.05) when fed birds with diets as had lower crude protein levels. The authors have reported that it may be due to the gradual depletion of body protein reserves in birds fed low dietary protein level as in the detail of results shown in Table 3.

Table 3. The effect of dietary SIDLL and low protein diets on egg quality of laying hens.

Dietary treatments	EW (g)	EST (mm)	ESG	EYC (score)	PEY (%)	PEA (%)	PES (%)
Dietary SIDLL (%)							
100	52.40	0.360	1.099	8.41	27.72	59.98	12.48
110	53.33	0.359	1.097	8.28	27.50	59.18	12.12
120	52.43	0.357	1.099	8.33	28.07	59.24	12.46
Dietary protein levels (%)[1]							
16.0	55.40[a]	0.358	1.099	8.33	27.73	59.97[a]	12.57
12.8	51.99[b]	0.356	1.099	8.34	27.80	57.72[b]	12.13
Main effects							
Dietary SIDLL[2]	NS	NS	NS	NS	NS	NS	NS
Dietary protein levels	*P*<0.05	NS	NS	NS	NS	*P*<0.05	NS
Dietary SIDLL x Dietary protein levels[2]	NS	NS	NS	NS	NS	NS	NS
SME[3]	0.39	0.004	0.014	0.113	0.406	0.685	0.115

[1]a,b Numbers with different superscripts differ statistically at *P*<0.05
[2]NS (non statistical differences)
[3]SEM (5 replicates of 45 hens each treatment)

CONCLUSION

The present study has shown that it can be used digestible essential amino acid (DEAA) and dietary formulation with 16.0% crude protein for the optimum levels to improve production performances and egg quality. However, It is also recommended that formulations be made on digestible essential amino acids to meet requirements more precisely. With the ever changing trend and consumer performances a better understanding of layer diet manipulation in feed formulation would be very important in order to survive in the very competitive layer industry. Lower feed price does not always mean cheaper production cost.

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