Effects of amino acids on egg number and egg mass of brown (heavy) and white (light) hens.

R.P.R.T. BONEKAMP[1*], A. LEMME[2], P.J.A. WIJTTEN[1] and J.K.W.M. SPARLA[1]

[1]Provimi B.V., P.O. Box 5063, NL-3008 AB, Rotterdam, the Netherlands, [2]Degussa GmbH-Feed Additives. Rodenbacher Chaussee 4, 63457 Hanau, Germany.
***Corresponding author: rbonekamp@nl.provimi.com**

Different types (light to heavy) of laying hens are used in practice and questions on optimum dietary amino acid supply raises. Therefore, a broad range of amino acid intake levels (500 through 750 mg apparent fecal digestible (AFD) Lys/h/d) was tested on light (Lohmann LSL Classic) and heavy (Lohmann Brown Classic) laying hens from 24 through 35 weeks of age. The other indispensable amino acids were fed in fixed ratios to AFD Lys in all treatments. A total of 564 hens (24 weeks of age) were divided into 12 experimental groups (individually housed) based on daily egg mass production and body weight. Diets were fed restrictively with an aimed feed intake of 110 g/h/d (298 kcal/h/d $AME_{n\ (layers)}$) and 100 g/h/d (277 kcal/h/d $AME_{n\ (layers)}$) for brown and white hens, respectively, to achieve the required amino acid intake levels. A daily intake of 650 mg AFD Lys was sufficient to maximise the laying % for brown hens and 550 mg AFD Lys intake for white hens. Egg weight, daily egg mass production and FCR improved up to the highest tested AFD Lys intake for both breeds, suggesting optimum AFD Lys intake of at least 750 mg/h/d for these criteria.

Keywords: Laying hens; amino acids; egg production; egg mass

Introduction

Literature that describes the effects of amino acid (AA) levels on layer performance is scarce. Hence, there is a demand for trial data that quantifies the daily requirements of AA intake on performance of modern type laying hens during different age periods.

In literature and often in practise AA-requirements for white (light) hens are assumed to be 10% lower than for brown (heavy) hens (Schutte, 1996). These assumptions are mainly based on rather old literature. Nowadays, different AA-recommendations for optimum laying % and optimum daily egg mass production are used. This requires a better understanding of different AA requirements for laying % versus daily egg mass production.

The present study was therefore, conducted to test if a broad range of amino acid levels will have similar effects on egg production and egg mass for light (Lohmann LSL Classic) and heavy (Lohmann Brown Classic) laying hens (24 through 35 weeks of age).

Materials and methods

The effect of different dietary amino acid intake levels (500, 550, 600, 650, 700 and 750 mg AFD Lys/h/d) on layer performance (24 through 35 weeks of age) was determined in the present experiment with heavy (Lohmann Brown Classic) and light (Lohmann LSL Classic) laying hens. The heavy hens were fed restrictively at 110 g/h/d (298 kcal/h/d $AME_{n\ (layers)}$) and the light hens were fed restrictively at 100 g/h/d (277 kcal/h/d $AME_{n\ (layers)}$). All treatment groups consisted of 47 layers each, divided over four replicates equally divided over the layer house. Each replicate consisted of 11 or 12 individually housed hens.

In total 600 17-weeks-old laying hens (300 Lohmann Brown Classic and 300 Lohmann LSL Classic) were purchased from a commercial rearing company. During the rearing period hens were subjected to a regular vaccination program. At arrival the birds were randomly divided over 600 double-deck battery cages (individually housed hens, cage size 0.2 x 0.5 m). In week 23 (3 days before the start of the experiment) all birds were weighed individually. At the start of the experiment (week 24), 564 hens were divided into 12 experimental groups and allocated to the treatment groups based on daily egg mass production during the two previous weeks and body weight. Treatment groups of the brown hens started with a similar average daily egg mass production (51.1 g/h/d), laying percentage (95.9 %) and hen weight (1860 g). Treatment groups of the white hens started with a similar average daily egg mass production (52.0 g/h/d), laying percentage (97.3%) and hen weight (1478 g). Bulb lights were on 10 hours a day at arrival, which was gradually increased to 16 hours a day in week 23 and remained at 16 hours a day until the end of the experiment. Temperature and ventilation were computer controlled. Temperature was set at 23°C throughout the experiment.

All experimental diets were prepared in a plant specialised in the production of experimental diets. In advance of diet formulation, batches of maize, wheat, wheat middling, barley, sunflower meal and soybean meal were reserved and analysed for N (Dumas), crude fat (6 h extraction with petroleum-ether), crude fibre content, crude ash (incineration at 550 ^{o}C for 4 h), dry matter (103 ^{o}C for 4 h), Calcium and Phosphorous (ICP). The results were verified by NIRS analysis. In addition, wheat middling, sunflower meal and soybean meal were analysed for AA content (Llames and Fontaine, 1994). Based on the analyses of the raw materials, the experimental diets with the highest and lowest AA levels were formulated (*Table 1*).

Table 1 Ingredient and nutritional composition of the highest and lowest AA diets.

Breed	Brown	White	Breed	Brown	White
Aimed feed intake, g/h/d	110	100	Aimed feed intake, g/h/d	110	100
AFD Lys, g/h/d	500	750	AFD Lys, g/h/d	500	750
Ingredient composition (g/kg)			*Nutritional composition[2] (g/kg)*		
Maize	490.3	332.2	Crude protein	120	174
Wheat	150.0	150.0	Crude fat	51	68
Soybean meal HP	23.0	165.5	Crude fibre	45	46
Lime	46.9	46.6	Crude ash	130	132
Limestone	46.9	46.6	$AME_{n\ (Layer)}$ (kcal/kg)[3]	2800	2800
Sunflower meal	90.0	90.0	$AME_{n\ (Poultry)}$ (kcal/kg)	2740	2720
Barley	50.0	50.0	AFD / TDF Lys[4]	4.55 / 5.05[5]	7.50 / 8.00
Wheat middlings	50.0	50.0	AFD / TDF Met	2.47 / 2.67	4.63 / 4.83
Animal fat	11.4	31.9	AFD / TDF Met + Cys	4.23 / 4.83	6.98 / 7.58
Soybean oil	11.6	11.9	AFD / TDF Thr	3.12 / 3.62	4.97 / 5.47
Standard premix[1]	10.0	10.0	AFD / TDF Trp	0.96 / 1.06	1.67 / 1.77
Monocalcium phosphate	9.6	8.8	AFD / TDF Ile	3.59 / 3.99	5.93 / 6.33
Potassium bicarbonate	5.00	-	AFD / TDF Arg	6.09 / 6.49	9.08 / 9.48
Sodium bicarbonate	1.74	1.57	AFD / TDF Val	4.48 / 4.98	6.76 / 7.26
Salt	1.08	1.34	Linoleic acid	20.0	20.0
L-Lysine HCl	2.11	1.45	Calcium	38.0	38.0
DL-Methionine	0.56	2.16	Phosphorus	5.9	6.2
Yolk colorants	0.07	0.08	Digestible Phosphorus	3.2	3.2
			Sodium	1.5	1.5
			Potassium	7.0	7.6
			Chloride	1.6	1.6

[1] Supplied per kg feed: 2.5 mg riboflavin, 5 mg niacinamide, 2 mg d-pantothenic acid, 12 µg cobalamin, 300 µg folic acid,5 mg Dl-α-tocopheryl acetate, 1,5 mg menadione, 3,44 mg retinyl-acetate, 50 µg cholecalciferol, 225 mg FeSO4.7H2O, 100 mg MnO2, 30 mg CuSO4.5H2O, 110 mg ZnSO4.H2O en 100 mg antioxidant (ethoxyquin).
[2] Nutritional composition: 'as is'
[3] According to Central Bureau for Livestock Feeding (CVB), Lelystad, The Netherlands (2001).
[4] AFD AA profile: Lys (100), Met (50), Met+Cys (93), Thr (66), Trp (19), Ile (79), Val (86) (Schutte, 1996).
[5] Apperant faecal digestible (AFD)/True faecal digestible (TFD) values between parentheses (AFD values plus endogenous losses CVB (2001)).

Diets were formulated based on body weight and expected energy requirement with the calculated feed intake of 110 g/h/d and 100 g/h/d for the brown and white breed, respectively, assuming a growth of approximately 10g per month. Protein + AA levels were increased by increasing the soybean meal content at the expense of maize while balancing with free amino acids. Diets were kept isocaloric by adjusting the soybean oil and animal fat content. The linoleic acid level of the diets was kept constant by varying the animal fat to soybean oil ratio. Potassium levels were kept within an acceptable range by varying the potassium bicarbonate content at the expense of maize. The remaining nutrients were fine tuned with the minerals and micro ingredients. The diets with the highest and lowest AA levels were produced first. The diets with intermediate AA levels were obtained by blending the two extreme diets in different ratios. Diets were fed in mash form. Diets were calculated to be adequate in all nutrients except protein and AA. All diets were analysed for N, crude fat, crude ash, dry matter, calcium, phosphorous and AA content, according to the same methods as used for the analyses of the diet ingredients.

During the pre-experimental period the hens had unlimited access to feed and during the experiment the hens were fed restrictively. All hens had unlimited access to drinking water before and during the experiment through one or two drinking-nipples per hen in the back of the cage.

Egg data and hen weights were collected per hen. All hens were individually weighed on the 4^{th} day in week 23 and 35 of life. Laying % was calculated as number of eggs produced per hen divided by the number of days of the experimental period. Egg weight was determined per hen once a week. Feed intake was determined per replicate. Feed conversion ratio was calculated as gram feed consumed per gram egg mass.

Linear and exponential regression analyses were performed on the averages per treatment and breed for the following variables: laying %, egg weight, egg mass production, feed conversion ratio and weight gain, with the following models:

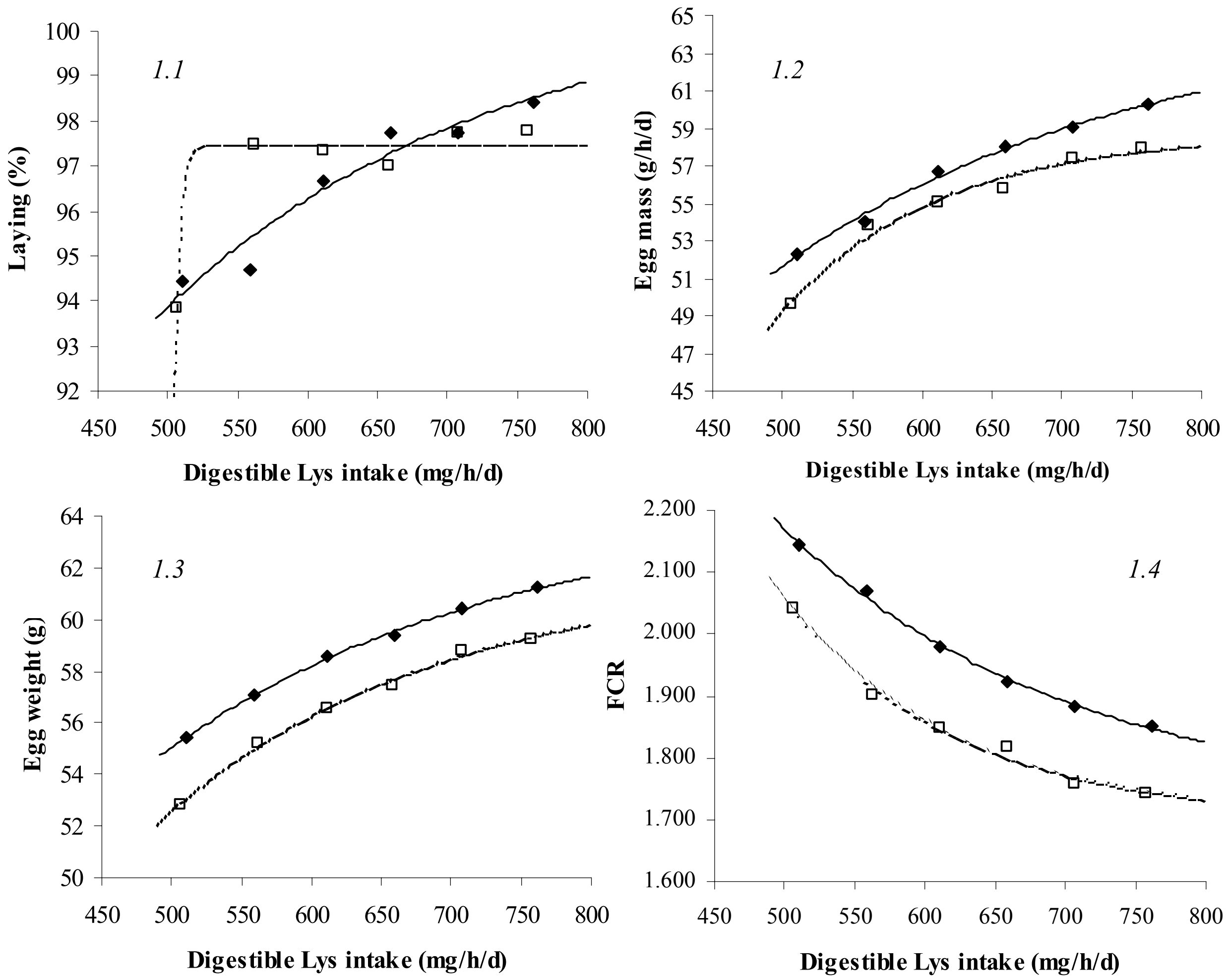
$$\text{Exponential } Y = a + b\,(1 - e^{-c(x-d)})$$

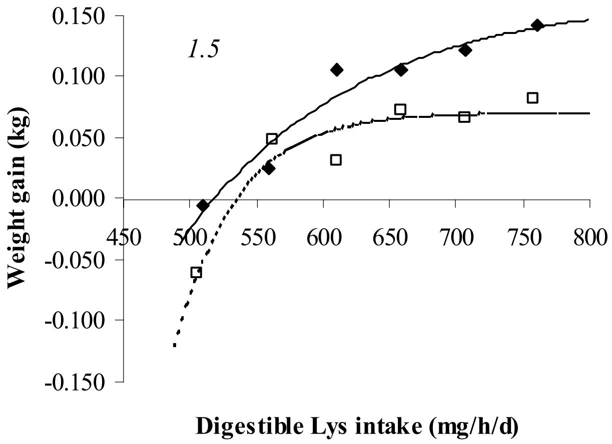
Where Y = dependent variable; a + b = asymptote; c = slope; d = lowest realised AFD Lys intake (mg/kg) per breed (brown 510 mg/h/d; white 506 mg/h/d); x = daily realised AFD Lys intake (mg/h/d).

Results and discussion

Analyses of the diets were in reasonable accordance with calculated values. Health status of the birds was good and mortality during the experiment was acceptable (5 birds, 0.9 %). Temperature in the room was close to the set temperature (23 ^{o}C) during the 12 experimental weeks. Laying % for the brown hens was significantly increased between 550 (94.7%) and 600 (96.7%) mg AFD Lys intake, whereas laying % seems to plateau at 650 (97.7%) mg AFD Lys. For the white hens the laying % reached a plateau at 550 mg AFD Lys (97.5%) (*Figure 1.1*). Egg weight, daily egg mass production and FCR improved non-linearly with increased AFD Lys intake in both heavy brown and light white hens, and no maximum/minimum performance could be established (*Figure 1.2, 1.3 and 1.4*). After the experimental period of 12 weeks most of the treatment groups gained weight (Brown hens: 82 g and white hens: 40 g). The aim was to allow a minimum weight gain of 10 g hen/month. The weight gain was expected, because the hens were still in the development stage of life. Both breeds showed decreased weights for the groups fed 500 mg AFD Lys over the entire period (*Figure 1.5*). This indicates that this level of amino acid intake is too low for maximum protein accretion and production of the hen.

The present experiment shows that a daily intake of 650 mg AFD Lys is sufficient to maximise the laying % for brown heavy hens and 550 mg AFD Lys to maximise laying % of white hens. However, the observed laying % and the decrease in weight within the lower AFD Lys treatments shows that especially for white layers this level is risky. Egg weight, daily egg mass production and FCR improved up to the highest tested AFD Lys level (750 mg) for both breeds. Therefore, the requirement for maximum egg weight and daily egg mass production was probably higher than 750 mg AFD Lys/hen/day. The slope of the curves slightly indicate that also for those parameters the required AFD Lys level for maximum performance is lower for white (light) than for brown (heavy) hens.





Exponential formulas corresponding with graph numbers:

1.1 Brown: $Y = 94.2 + 6.67\ (1\text{-}e^{-0.004\ (X\text{-}510)})$, $R^2 = 0.90$, $p = 0.02$
White: $Y = 93.9 + 3.62\ (1\text{-}e^{-0.26\ (X\text{-}506)})$, $R^2 = 0.94$, $p < 0.01$

1.2 Brown: $Y = 52.2 + 12.84\ (1\text{-}e^{-0.004\ (X\text{-}510)})$, $R^2 = 0.99$, $p < 0.001$
White: $Y = 49.8 + 9.00\ (1\text{-}e^{-0.009\ (X\text{-}506)})$, $R^2 = 0.97$, $p = 0.002$

1.3 Brown: $Y = 55.4 + 8.88\ (1\text{-}e^{-0.004\ (X\text{-}510)})$, $R^2 = 0.99$, $p < 0.001$
White: $Y = 52.9 + 9.00\ (1\text{-}e^{-0.005\ (X\text{-}506)})$, $R^2 = 0.99$, $p < 0.001$

1.4 Brown: $Y = 2.148 - 0.43\ (1\text{-}e^{-0.005\ (X\text{-}510)})$, $R^2 = 0.99$, $p < 0.001$
White: $Y = 2.037 - 0.34\ (1\text{-}e^{-0.008\ (X\text{-}506)})$, $R^2 = 0.98$, $p < 0.001$

1.5 Brown: $Y = -0.011 + 0.18\ (1\text{-}e^{-0.008\ (X\text{-}510)})$, $R^2 = 0.91$, $p = 0.013$
White: $Y = -0.059 + 0.13\ (1\text{-}e^{-0.022\ (X\text{-}506)})$, $R^2 = 0.86$, $p = 0.024$

Figure 1 Exponential regression analyses for laying %, egg mass, egg weight, feed conversion ratio (FCR) and weight gain for brown (♦ ——) and white (□ ····) laying hens.

References

CVB (Centraal Veevoederbureau). (2001) Veevoedertabel (Livestock Feed Table). Central Bureau for Livestock Feeding (CVB), Lelystad, The Netherlands.

Llames, C. and Fontaine, J. (1994) Determination of amino acids in feeds: collaborative study. *J. AOAC Int.* **77**:1362-1402.

Schutte, J.B. (1996) Aminozuurbehoeften van leghennen en vleeskuiken. *CVB-documentatie-rapport,* No. **18**.