

Protein (Amino acid) metabolism of high productive laying hens

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Abstract

Results of respiration trails, including complete protein (amino acids) and nutrient balances, with two strains of high productive laying hens (Lohmann BROWN and Lohmann LSL) were carried out. Described are only the results of protein (AA) metabolism with recommendations and conclusions for requirements and feeding strategies.

Key words: laying hens, protein metabolism, amino acids resorption, secretion

Introduction

The aim of this investigation was to determine the energy and nutrient metabolism of two high productive strains of laying hens (Lohmann Brown (LB) and Lohmann White (LSL)). The aim of this paper is to present and analysed the results of protein (Amino acid (AA)) metabolism in dependence on feed composition as fundamentals for feed strategies.

Materials and Methods

Respiration experiments (climatically controlled respiration chamber with 4 cages a' 3 hens (n= 12), 27 measuring periods of 4 – 18 days) were carried out in two series with two groups, in each 12 or 8 laying hens – LB (BW 1840±106 g) and LSL BW 1530±82 g) in series 1 with 6 or only LB (BW 1888±43 g) in series 2 with 10 different treatments; both in the course of laying period from 18th to 77th week of age. The hens were fed ad libitum. The variations of exogenous factors were: Feed composition: Protein 16.1 – 26.9 %, fat 2.7 – 9.1 % and starch+sugar 32.2 – 49.8 % of DM; temperature 5 – 30 °C; light program 12h /12 h or 3h/3h and 8h/10h light/dark per day.

The heat production (HP) (indirect calorimetry over 24 h, measurement of O₂ consumption and CO₂ production continuously (air input, chamber gas concentration every 20 sec.), HP calculated according to BROUWER(1965) (C- and N-balance)) was measured daily. The excrements were collected totally, mixed, fresh (N) and frozen dried analysed, as well as the feeds and eggs, by standard methods: N, C, energy (E), amino acids (AA) and feed analyses (WEENDE): (dry matter (DM), ash (A), crude protein (CP), crude fat (CF), starch (ST), sugar (SU) and in difference to organic matter (OM) the N-free residue (NFR). The differences between total N and amino acids N in excrements are calculated as urine N. Therefore we get complete N-, C-, energy-, protein and amino acid as well as nutrient balances.

Results and Discussion

The feed intake was relatively low and depends significantly (p<0.01) on environmental temperature: It was up to 14 % higher at 10 °C and up to 23 % lower at 30 °C, compared to at 22 °C. The lighting programs are summing-up over 24 h without influence, but the differences in gas exchange and heat production are between light (135 %) and dark periods (75 %) 60 % of the daily average by influence of different physical activity. The egg production (EP) was high (over 90 %) and very stable. LB tended to have higher feed intake and egg production; but in average the feed conversion is equal to LSL. The lower temperature declined the feed conversion up to 2.0 or 1.82 kg DM/kg egg mass in LB and LSL, respectively; higher temperature improved the feed efficiency for both strains to 1.45 kg DM/kg egg mass. But this result is also caused the low feed intake and therefore the utilisation of body nutrients as energy source. The analysis of body composition revealed that the majority of the 300 g BW-differences between LB and LSL is metabolic inactive fat (100 g from 184 g DM-difference!).

The basic metabolism of egg production is between the strains, expressed in absolute dates, equal. Therefore is it for the compare of metabolic dates not useful to relate these dates to metabolic body size. In the following are discussed only relationships of fundamental importance in protein (essential AA) metabolism.

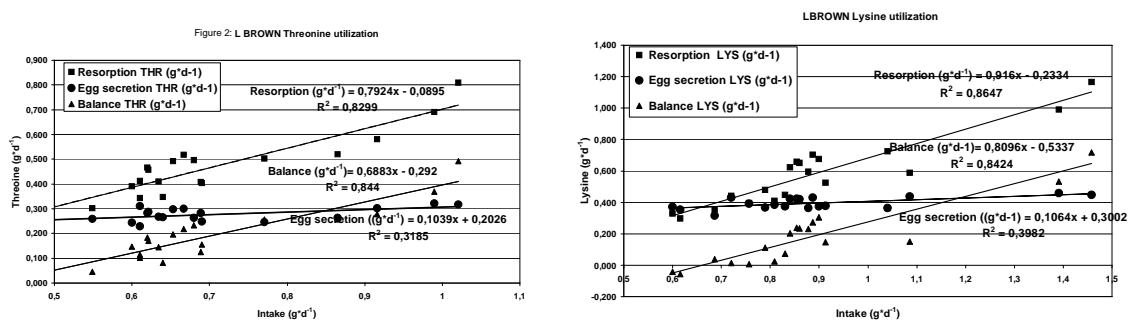
Amino acid metabolism

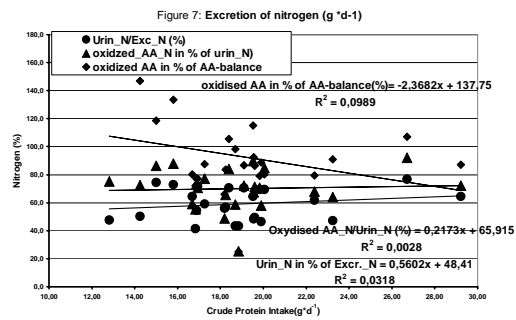
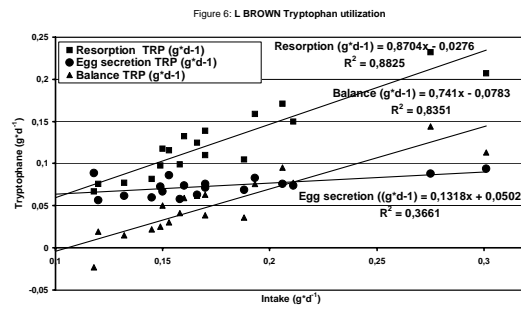
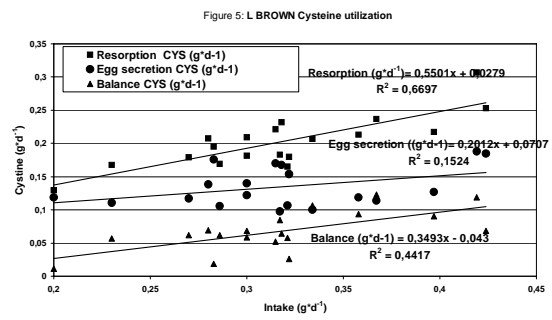
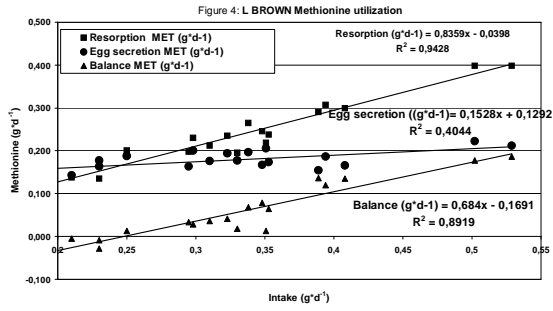
The metabolism of AA-protein ($\text{g} \cdot \text{d}^{-1}$) in dependents on intake is shown in figure 1.

Concerning the AA balancing one should have a special feature in poultry because the AA balance includes the AA, which are retained in body and/or oxidised. Summarised, the oxidised AA one can calculate out of the AA balance – N-balance*6.25 (protein balance). The metabolizable AA-protein (Resorption) and the intake were correlative ($0.76 \text{ g} \cdot \text{g}^{-1}$, $R^2=0,75$), as well as the balance of AA (= AA intake – AA excretion – AA egg secretion) ($0.65 \text{ g} \cdot \text{g}^{-1}$, $R^2=0,70$) and the oxidized AA-protein (= AA balance – AA body retention) admittedly with lower dependence ($0.58 \text{ g} \cdot \text{g}^{-1}$, $R^2=0.50$). The body retention of AA (= balance N * 6,25) is very low and independent of AA intake ($0,06 \text{ g} \cdot \text{g}^{-1}$, $R^2=0,03$). The AA-protein secretion in the eggs shows also only small dependence on the intake of AA, but the efficiency is very low ($0.11 \text{ g} \cdot \text{g}^{-1}$, $R^2=0,40$). A practical possibility for a markedly influence for higher AA contents in the eggs is not given. The relationships between intake and egg secretion of AA are different for the single essential AA (figure 2 – 5): The dependence of egg secretion on the intake of the AA is quantified about the regression equations in the graduation of cysteine ($0,20 \text{ g} \cdot \text{g}^{-1}$, $R^2 = 0,15$) > methionine ($0,15 \text{ g} \cdot \text{g}^{-1}$, $R^2 = 0,40$) > tryptophan ($0,13 \text{ g} \cdot \text{g}^{-1}$, $R^2 = 0,37$) > lysine ($0,11 \text{ g} \cdot \text{g}^{-1}$, $R^2 = 0,40$) and threonine ($0,10 \text{ g} \cdot \text{g}^{-1}$, $R^2 = 0,31$). Hence, in the commercial use one should concern the costs. Otherwise tight relationships are found between intake and resorption and AA balance, which represents the independence of digestibility and AA retention in eggs and body protein on AA intake, respectively.

Table 1: Regression equations ($x= \text{g Intake} \cdot \text{d}^{-1}$)

Amino acid	Resorption AA		Balance AA		Egg secretion AA	
Threonine	$0,79x - 0,090$	$R^2 = 0,83$	$0,69x - 0,292$	$R^2 = 0,84$	$0,104x + 0,203$	$R^2 = 0,31$
Lysine	$0,92x - 0,233$	$R^2 = 0,86$	$0,81x - 0,533$	$R^2 = 0,84$	$0,106x + 0,300$	$R^2 = 0,40$
Cysteine	$0,55x + 0,028$	$R^2 = 0,67$	$0,35x - 0,043$	$R^2 = 0,44$	$0,201x + 0,071$	$R^2 = 0,15$
Methionine	$0,84x - 0,040$	$R^2 = 0,94$	$0,68x - 0,169$	$R^2 = 0,89$	$0,153x + 0,129$	$R^2 = 0,40$
Tryptophan	$0,87x - 0,028$	$R^2 = 0,88$	$0,74x - 0,078$	$R^2 = 0,84$	$0,132x + 0,050$	$R^2 = 0,37$





Conclusions

The conclusion is that laying hens higher supplies of AA can not markedly used for an increase of AA secretion in the eggs and/or higher body protein retention. The surplus of AA were desaminated (oxidized) for energy supply and/or fat synthesis in the amount of $92,9 \pm 26,9 \%$ (25 % – 156 %) of AA balance, that means $70,0 \pm 14,6 \%$ (25 % to 92 %) of urine N (= N-excrements – AA_N) are caused by desamination of AA (figure 7).

Generally, higher AA intakes as the requirements for maintenance function and egg production are not efficient for egg production.

We recommend the requirements of both high productive strains of laying hens to yield effective egg production as following:

Requirement of amino acids ($\text{g} \cdot \text{hen}^{-1} \cdot \text{d}^{-1}$)

	THR	LYS	CYS	MET	TRP	AA-Protein
Egg-Sekretion	0,27	0,38	0,12	0,16	0,07	5,5
Feed - gross amino acids	0,65	0,85	0,30	0,30	0,17	16,0
- digestible amino acids	0,46	0,56	0,21	0,22	0,13	11,7

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