Effect of dietary energy to digestible methionine ratio on performance of organic housed laying hens

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Abstract

An experiment was conducted to determine the effect of energy to methionine (MET) ratio on egg performance in organic housed laying hens (from 22 to 34 wk of age) during summer and winter. A total of 128 17-wk old Brown Nick hens were allotted to 16 pens. Each pen was connected to an outdoor run. The experiment comprised 8 dietary treatments according to a 4×2 factorial design. The factors were MET level (2.3, 2.7, 3.1 and 3.5 g/kg) and energy content (2600 and 2900 kcal). Treatments were applied during both seasons, resulting in 4 replicates per treatment. In the summer period, dietary energy content did not affect energy intake (313 kcal/d), whereas energy intake in the winter period was increased in hens that were fed high energy diets (362 *vs.* 381 kcal/d, $p<0.001$). During summer, egg mass linearly increased with increasing dietary MET content. Maximal egg mass was realized by supplementing diets with 3.5 g/kg digestible (dig.) MET, corresponding to a dig. MET intake of 400 mg/d. During winter, maximal egg mass was achieved with a dig. MET intake of 350 mg/d, which was already realized with a dig. MET content of 2.7 g/kg. Egg mass (g/d) could be predicted by the equation: 0.119 × energy intake (kcal/d) + 0.082 × MET intake (mg/d) - 1.65 × daily gain (g/d) - 0.818 × inside temperature (°C) ($R^2 = 0.80$). Based on these results, it can be concluded that dietary energy to MET ratio should be adjusted to seasonal conditions.

Key words: laying hens; methionine; organic; performance

Introduction

It is stated that the main dietary challenge in organic laying hen production is to fulfill the protein requirement, especially the MET requirement (Elwinger et al 2008). In poultry diets, the amino acid (AA) MET is the first limiting AA (NRC 1994). Environmental factors, like ambient temperature, seasonal effects and housing system might affect feed intake of laying fowl (Chwalibog and Baldwin 1995; Roth and Bohmer 2008). Hens will compensate for these increased requirements by higher feed intake (Herremans et al 1989; Luiting 1990; Peguri and Coon 1993). It is assumed, however, that hen's daily requirements for nutrients, other than energy, are not changed by the level of feed consumption (NRC 1994). If this assumption is valid, contents of other dietary nutrients, like AA, could be adjusted to the feed intake level of the hens. Because feed intake level of organic housed laying hens is rather high, this might provide new challenges for the diet composition of organic housed laying hens. Therefore, an experiment was conducted to determine the effect of energy to MET ratio on egg performance and plumage condition in organic housed laying hens, that were fed diets with a low (2600 kcal) or a high (2900 kcal) energy content during summer and winter and four dietary dig. MET levels. It is hypothesized that organic housed laying hens have higher requirements for energy, but similar requirements for AA, resulting in an increased dietary energy to AA ratio for optimal egg performance, compared to conventional housed layers.

Material and methods

Two separate flocks, each of 128 17-wk old Brown Nick hens with intact beaks, that were reared under organic conditions, were allotted to 16 pens during a summer and winter trial, respectively. Each pen was connected to an outdoor run. The experiment comprised eight dietary treatments according to a 4 × 2 factorial design. The factors were dig. MET level (2.3, 2.7, 3.1 and 3.5 g/kg) and AME_N content (2600 and 2900 kcal/kg). The calculated ratios of dig. MET to dig. LYS, CYS, THR, and TRY were constant in all diets. Ratio of AME_N to vitamins and minerals was similar for all diets. Treatments were applied during both seasons, resulting in four replicates per treatment. Feed intake and egg performance per pen were recorded weekly. In a 4-wk interval, hens were weighed per pen, whereas plumage and skin condition per individual hen were scored by using the method of Bilcik and Keeling (1999). Temperature was recorded on a daily base inside the room and in the outdoor area.

Results and discussion

During summer, average min. and max. temperature amounted in the house 16.5°C and 21.3°C, and outside the house 10.2°C and 19.7°C, respectively. During winter, average min. and max. temperature amounted in the house 8.7°C and 14.4°C, and outside the house 0.2°C and 5.5°C, respectively. In the summer period, dietary energy content did not affect energy intake (313 kcal/d), whereas energy intake in the winter period was increased in hens that were fed high energy diets (362 *vs.* 381 kcal/d, $p<0.001$) (Table 1). Apparently, hens were not able to consume enough 'low energy feed' during winter to fulfill their energy requirements. Increasing the dig. MET content resulted in increased MET intake (Table 2), indicating that no feedback mechanisms on feed intake were activated in the range of tested MET contents. During summer, egg mass linearly increased with increasing dietary MET content (Table 2). Maximal egg mass in summer was realized by supplementing diets with 3.5 g/kg dig. MET, corresponding to a dig. MET intake of 406 mg/d. During winter, maximal egg mass was achieved with a dig. MET intake of 352 mg/d, which was already realized with a dig. MET content of 2.7 g/kg. Energy intake was affected by an interaction between dietary energy and MET content. In low energy diets, energy intake of hens that were fed 3.5 g/kg dig MET was reduced compared to the 2.3 and 2.7 MET treatments, whereas in the high energy diets, energy intake was not affected by MET content (Table 3). Egg weight was not affected by dietary energy content in the 2.7 and 3.5 MET treatments, whereas in the high energy treatment egg weight was reduced in hens that were fed the 2.3 (57.5 vs. 54.7 g) and 3.1 (59.1 vs. 57.8 g) g/kg dig. MET compared to the low energy treatment. In the 2.7, 3.1 and 3.5 MET treatments, egg mass was not affected by dietary energy content, whereas in the 2.3 MET treatment, egg mass was reduced in hens that were fed the high energy diet, compared to the low energy diet (48.5 vs. 44.4 g/hen/d).

Based on the results of this experiment, egg mass (g/d) could be predicted by the equation [1]: 0.119 × energy intake (kcal/d) + 0.082 × MET intake (mg/d) - 1.650 × daily gain (g/d) - 0.818 × inside temperature (°C) ($R^2 = 0.80$).

Energy intake (kcal/d) could be predicted by the equation [2]: 0.505 × rate of lay (%) + 4.354 × egg weight (g) + 2.687 × daily gain (g) + 0.056 × Energy to dig. MET ratio + 13.37 × Feather damage score – 2.116 × inside temperature (°C) ($R^2 = 0.72$). All parameters in both equations had a significant ($p<0.05$) contribution to those equations.

Conclusions

Based on these results, it can be concluded that dietary energy to MET ratio should be adjusted to seasonal conditions. Digestible MET content in diets of organic laying hens can be significantly reduced from 3.1 to 2.7 g/kg at low temperatures, without negatively affecting hen performance.

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Table 1. Effect of interaction between season and energy levels on organic laying hen performance from 24-34 weeks of age[1]

Treatments	FI (g/d)	FCR	EI (kcal/d)	MI (mg/d)	Laying (%)	EW (g)	EM (g/d)
Summer							
Low Energy	120.4[c]	2.35	313.0[c]	349.9[c]	85.13[b]	58.21	50.13[b]
High Energy	107.7[d]	2.42	312.4[c]	313.9[d]	81.24[c]	56.60	46.49[c]
Winter							
Low Energy	132.4[a]	2.65	344.1[b]	381.4[a]	96.30[a]	58.75	56.44[a]
High Energy	125.1[b]	2.47	363.0[a]	361.6[b]	96.55[a]	57.90	56.21[a]
SE	1.08	0.08	3.0	3.2	1.19	0.31	0.74
P-value	0.016	0.611	0.001	0.027	0.043	0.097	0.009

[ab] means in the same row with different superscripts are significantly different (p <0.05)
[1]FI=Feed intake; FCR=Feed conversion ratio; EI=Energy intake; MI= Methionine intake; EW=Egg weight; EM=Egg mass

Table 2. Effect of interaction between season and methionine levels on organic laying hen performance from 24-34 weeks of age[1]

	FI (g/d)	FCR	EI (kcal/d)	MI (mg/d)	Laying (%)	EW (g)	EM (g/d)
Summer							
2.3 MET	107.9[e]	3.06[a]	295.8[e]	247.7[g]	71.84[d]	54.33[c]	39.40[d]
2.7 MET	114.6[d]	2.42[b]	313.9[d]	308.8[f]	84.33[c]	58.34[ab]	49.25[c]
3.1 MET	117.6[d]	2.49[b]	322.6[d]	364.6[d]	85.87[c]	57.90[b]	50.36[c]
3.5 MET	115.9[d]	2.27[bc]	318.6[d]	406.4[b]	90.69[b]	59.05[a]	54.22[b]
Winter							
2.3 MET	134.5[a]	2.51[b]	369.2[a]	309.4[f]	92.89[ab]	57.84[b]	53.41[b]
2.7 MET	130.3[b]	2.36[bc]	357.8[b]	352.0[e]	96.16[a]	58.68[ab]	56.58[a]
3.1 MET	126.4[c]	2.16[c]	347.2[c]	391.4[c]	97.62[a]	58.96[a]	57.56[a]
3.5 MET	123.9[c]	2.16[c]	340.0[c]	433.3[a]	99.02[a]	57.82[b]	57.74[a]
SE	1.6	0.11	4.5	4.7	1.8	0.53	1.1
P-value	<0.001	0.010	<0.001	<0.001	<0.001	<0.001	0.001

^{ab} means in the same row with different superscripts are significantly different ($p < 0.05$)
[1]FI=Feed intake; FCR=Feed conversion ratio; EI=Energy intake; MI= Methionine intake; EW=Egg weight; EM=Egg mass

Table 3. Effect of interaction between energy and methionine levels on organic laying hen performance from 24-34 weeks of age[1]

	FI (g/d)	FCR	EI (kcal/d)	MI (mg/d)	Laying (%)	EW (g)	EM (g/d)
Low energy							
2.3 MET	127.60^{a}	2.84	331.80^{abc}	293.8	84.34	57.50^{d}	48.50^{e}
2.7 MET	127.20^{a}	2.45	331.70^{bc}	343.7	90.89	58.65^{abc}	53.40^{bcd}
3.1 MET	126.60^{a}	2.43	329.20^{cd}	392.2	91.88	59.07^{a}	54.70^{abc}
3.5 MET	123.60^{b}	2.29	321.50^{d}	432.8	95.74	58.70^{ab}	56.60^{a}
High energy							
2.3 MET	114.90^{c}	2.74	333.20^{abc}	263.3	80.39	54.66^{e}	44.40^{f}
2.7 MET	117.20^{c}	2.33	339.90^{ab}	317.1	89.59	58.37^{abc}	52.40^{d}
3.1 MET	117.40^{c}	2.22	340.60^{a}	363.8	91.62	57.79^{cd}	53.20^{cd}
3.5 MET	116.20^{c}	2.15	337.10^{abc}	406.9	93.97	58.17^{bcd}	55.40^{ab}
SE	1.57	0.12	4.41	4.6	1.72	0.43	1.07
P-value	0.024	0.988	0.045	0.177	0.570	<0.001	0.041

^{ab} means in the same row with different superscripts are significantly different ($p < 0.05$)
[1]FI=Feed intake; FCR=Feed conversion ratio; EI=Energy intake; MI= Methionine intake; EW=Egg weight; EM=Egg mass