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Energy Balance of Laying Hens under Different Climates

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RINGKASAN

Beberapa kajian jangka pendek (3–4 minggu) berkaitan dengan perseimbangan energi dijalankan didalam iklim temperate dan tropika. Keputusan menunjukkan ayam betina yang menerima kurang makanan dapat mengeluarkan telor dan mempertahankan perseimbangan energi yang positif. Ini adalah disebabkan kemorosotan berat badan dan keperluan nutrient-nutrient untuk maintenance badan dikurangkan. Jumlah penghasilan haba bagi iklim temperate dan tropika ialah 173 dan 198 kcal/kg$^{0.75}$ berikutan.

SUMMARY

A series of short term (3–4 weeks) energy balance experiments on laying hens were carried out under temperate and tropical climates. The results indicated that hens on ME restriction could produce egg while at the same time maintained positive energy balance. This was possible because nutrient requirements to maintain higher body weight which resulted from energy restriction, could have been reduced. Total heat production data obtained for temperate and tropical climates were 172 and 187 kcal/kg$^{0.75}$ respectively.

INTRODUCTION

Under *ad lib.* feeding, laying hens tend to maintain a positive energy balance. On the other hand prolonged severe restriction of energy intake results in loss of body energy. Limited energy restriction over short term does not result in reduced egg production (Pope, 1971, Snetsinger and Zimmerman, 1974). Under such conditions energy deficiency is compensated by body energy and leads to loss of body weight. This could affect the energy requirement of hens and therefore there is a need to study such an effect on energy balance of laying hens. The present study was carried out in both temperate and tropical climates.

MATERIALS AND METHODS

Two basal rations (Table 1) containing about 16% crude protein and 2800 kcal/kg of metabilizable energy (ME) were compounded. *Ad lib.* consumption of basal rations by hens were determined during the two weeks acclimatization period.

Experiment 1 was conducted under controlled environment 16 ± 1°C in England while Experiment 2 was run under an uncontrolled tropical environment of Malaysia with daily temperature and relative humidity ranging from 27 to 32°C and 80 to 90 per cent respectively.

In each experiment 18 commercial hybrid layers, Babcock and Shavers 288 strains of 30 week-old were used for Experiments 1 and 2 respectively. The experiments were arranged in a randomized block design based on body weights. The hens were divided into three groups each with six hens for both experiments. The first group in each experiment was killed to determine the initial carcass energy. The second group was allowed *ad lib.* feeding while the third group had energy intake restricted to about 250 ME kcal/d. Other dietary components were provided in the same amount as the control by supplementation as shown in Table 2. Each hen was a replicate.

The hens were commonly kept in single cages equipped with an independent feeding trough and drinkers. Egg produced was collected daily and weighted. Body weight and excreta produced were recorded every three days.

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TABLE 1

Composition of Control Rations

Ingredients	Experiment 1 %	Experiment 2 %
Maize meal	40	40
Wheat meal	35	35
Soyabean meal	8.75	9
Fish meal	7.50	8.5
Limestone	8.00	6.5
Dicalcium phosphate	0.31	–
Salt	0.22	0.5
Beta trace elements	0.22	
Biostock and vitamins	–	0.5
Total	100.00	100.00
Chemical composition		
Crude protein (% N×6.25)	16.7	16.5
ME (kcal/kg)	2833	2866
Calorie: protein ratio	169.6	173.7
Calcium (%)	3.5	3.1
Phosphorus (%)	0.5	0.5

TABLE 2

Ingredients Supplemented Per 100 kg of basal Diet

Ingredients	Experiment 1 kg	Experiment 2 kg
Fish meal	6.25	8.08
Limestone	2.00	2.15
Salt and Trace elements	0.90	0.13

After 27 days of trials, all the hens were killed for carcass analysis. Chemical analysis were carried out on samples of carcass, feed, excreta and eggs. ME of feeds were also determined. Energy balance on live hens was estimated every three days. Body energy content was calculated based on Hassan's value (1969) of 5 kcal/g live weight.

RESULTS

Experiment 1

Data on nutrient intake and egg production and live weight of hens are presented in Table 3. Hens on restriction consumed 31 per cent less feed compared to those on *ad lib.* and has significantly ($P < 0.01$) lower body weight. These hens also laid significantly ($P < 0.01$) smaller egg. The reduction in egg number was not statistically significant.

TABLE 3

Summary of Data on Performance and Nutrient Intake
(Values are Mean of 6 Hens)

Parameters	Experiment 1		Experiment 2	
	Ad lib.	Restricted	*Ad lib.*	Restricted
Initial liveweight (kg)	1694	1643	1456	1438
Final liveweight (kg)	1709	1500	1497	1376
Change in liveweight (g)	15	−143**	41	−62
Feed consumed (g/bird/d)	123	84	99	81
ME consumed (kcal/bird/d)	348	252	282	251
Crude protein intake (g/bird/h)	20.5	20.5	16.3	16.9
Egg production (%)	79	67	46	40
Egg weight (g)	63	58**	49.5	48
Gross energetic efficiency %	22	24	11.5	10.7

**Significantly different at $P < 0.001$

Notes: $\text{Gross energetic efficiency} = \frac{\text{egg energy}}{\text{ME consumed}} \times 100$

Hens on energy restriction rapidly lost body energy during the initial 12 days (Table 4) but appeared to stabilise thereafter. The changes in body energy of hens on *ad lib.* was small though there were instances of negative balance (Table 4).

Data on heat production $kg^{0.75}$ was calculated as a difference between ME intake and energy retained (which is egg energy and change in body energy). The values obtained (Table 4) under different periods varied to a great extent in both groups. The values obtained for hens on *ad lib.* and restriction ranged from 155 to 206 and 137 to 232 kcal/$kg^{0.75}$, respectively. The means obtained were 179 and 166 kcal/$kg^{0.75}$, respectively for hens on *ad lib.* and restriction.

Experiment 2

ME intake of hens on *ad lib.* was about 282 kcal/d as compared to 348 kcal/d consumed by hens on similar treatment in Experiment 1. The difference in consumption between *ad lib.* and restricted groups in this experiment was only 15 per cent. Hens in both groups gained body weight but the difference was not significant (Table 3). Differences in egg number and individual size were also not significant although hens on restriction produced a slightly less number, and smaller eggs (Table 3).

Results on body energy change were inconsistent. Hens on *ad lib.* had greater daily body energy fluctuation when compared to those on restriction (Table 4).

Heat production ($kg^{0.75}$) ranged from 103–218 kcal/$kg^{0.75}$ for hens on control and from 159–232 kcal/$kg^{0.75}$ for hens on restriction. The means were 178 and 196 kcal/$kg^{0.75}$ respectively.

DISCUSSION

Data (Table 3) on voluntary energy intake indicated that it was affected by climate. Hens on *ad lib.* feeding in the tropics (Experiment 2) consumed on an average 66 ME kcal/d less than those reared in the temperate climate (Experiment 1). This represents a difference of about 19 per cent. As a consequence restricting hens to 250 ME kcal/d represented 72 and 89 per cent of *ad lib.* under temperate and tropical climates respectively. The severity of restriction in the latter group was somewhat reduced and caused only a small reduction in body weight which was not significantly different from the control. Hens in this category lost an average of 62 g or about 4.3 per cent of body weight over a period of 27 days.

Imposing restriction of ME intake on hens under temperate climate resulted in a loss of body energy at initial stages. Body energy balance was again positive towards the final phases. This could have been due to possible reduction in maintenance requirement and helped to stabilise body weight and maintained egg production. Similarly Auckland and Fulton (1974) showed that hens under varying levels of energy restriction initially lost body weight in the margin of 6 to 12 per cent but later stabilised at a lower level. Energy balance performed on hens under tropical climate did not indicate any particular trend (Table 4). Body energy was calculated on the basis of liveweight. Live weight of hen under tropical climates can be greatly influenced by body water status. Estimation of body energy in this manner may not be highly accurate especially at short intervals.

Egg production was comparatively higher under temperate climate (Table 3). Hens on ME restriction produced less and smaller eggs compared to the control under both climates. However, only the difference between egg size of hens in temperate climates was statistically significant.

Results on heat production ($kg^{0.75}$) were pooled and the mean values obtained for Experiments 1 and 2 were 172 and 187 kcal/$kg^{0.75}$, respectively. Although heat production values were higher than those obtained by other workers, the trend in results is in line with more recent findings (Jalaludin 1976). This probably explains why hens under tropical climate laid fewer and smaller eggs even at constant ME intake.

Restricting ME intake to 250 kcal/d did not significantly affect egg production under both climates. It appears that egg production was maintained at the expensed of body weight. In case of more severe restriction (as in Experiment 1) egg size was also reduced. The laying hens thus demonstrated the ability to tolerate ME restriction by adjusting body weight and maintaining egg production.

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TABLE 4

Summary of Energy Balance for Every 3 Days Periods. Means of 6 Hens (kcal)

Period	Days	Energy Intake				Egg Energy				Body Energy				Heat Produced W $kg^{0.75}$			
		Experiment 1		Experiment 2		Experiment 1		Experiment 2		Experiment 1		Experiment 2		Experiment 1		Experiment 2	
		Res.	Con.	Res.	Con.	Res.	Con.	Res.	Con.	Res.	Con.	Res.	Con.	Res.	Con.	Res.	Con.
1	3	250	358	249	258	86	86	34	39	−157	− 7	−77	−35	232	189	229	194
2	6	260	372	249	258	95	89	19	15	− 23	− 6	5	106	142	195	199	103
3	9	251	397	251	290	77	79	18	27	− 60	11	2	41	166	206	180	162
4	12	251	331	254	291	57	81	21	35	− 38	9	27	−19	172	165	159	201
5	15	261	331	250	287	61	73	15	50	17	2	10	−17	144	173	174	190
6	18	262	350	252	282	44	66	22	27	− 42	28	−45	46	195	172	217	170
7	21	258	334	253	299	49	88	33	31	26	−17	3	−19	137	177	170	216
8	24	258	345	252	285	36	72	42	37	8	13	17	41	160	176	232	151
9	27	263	382	252	283	51	79	39	36	18	5	43	−47	144	155	202	218
Mean																	

Notes: Res. – restricted hen
Con. – control hen

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