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THE EFFECT OF HIGH ENVIRONMENTAL TEMPERATURE ON RESPONSES OF LAYING HENS TO CHOICE FEEDING IN A SINGLE FEEDER

Y. L. Henuk[1]

Abstract

An experiment was conducted for 10 weeks to examine the ability of hens to meet their energy, protein and Ca requirements by selecting their own diet at a high environmental temperature. Laying hens allowed to self-select feedstuffs from whole maize, protein meal and oyster-shell grit which were provided *ad libitum* in a single feeder at environmental temperature 32°C, were able to lay more eggs of larger size and gained more body weight, while maintaining similar total feed intake, FCR, ME intake, protein intake, Ca intake, Haugh Unit, yolk colour, egg-shell thickness and egg specific gravity compared to laying hens fed a complete, meal diet.

Key words: High temperature, Choice feeding, Single feeder, Laying hens

Introduction

The main concern under the conditions of high environmental temperature is the layer's ability to consume sufficient feed to satisfy its nutrient requirements. When the body temperature of poultry increases above the thermo-neutral range (i.e. 18 to 26°C), then less heat is required by laying hens to maintain body temperature and so the birds given a complete diet consume less feed (Leeson and Summers, 1991; Forbes and Shariatmadari, 1994). Van Kampen (1981) reported that the feed intake of laying hens is also depressed in hot environments in order to reduce the metabolic rate and hence body heat load. Concomitant with reduced feed intake in laying hens given complete diets at constant high environmental temperatures were reductions in egg production, egg weight and eggshell quality (Austic, 1985).

By contrast, choice feeding offers an interesting alternative to complete diets because laying hens fed in this way have the opportunity to balance their own nutrient intakes appropriate to their environment (Mastika and Cumming, 1985; Shariatmadari and Forbes, 1993; Forbes and Shariatmadari, 1994). The former authors also suggested that choice feeding is probably a valuable tool to help in solving the problem of decreasing nutrient intake experienced by laying hens in the hot environments of the tropics.

[1] Faculty of Agriculture, University of Nusa Cendana (Kotak Pos 104, Kupang, N.T.T. 85001 Indonesia. Phone: 62-0380-882085; Fax: 62-0380-881580; E-mail: yusufhenuk@hotmail.com).

However, very few investigations have introduced choice feeding to laying hens at an early age (before the commencement of lay) and then measured their production at a constant high temperature. Besides that, there is no information available on the choice feeding of whole maize grain plus a protein meal mixture with oyster-shell grit in a single feeder. In our previous studies, we found that layers can meet their nutrient requirements by self-selecting from whole wheat, a protein concentrate and oyster-shell grit on a free-choice basis in a single feeder at a 'normal' (20°C) and 'high' (32°C) environmental temperatures (Henuk *et al.*, 2000). The present study, along the same lines as our previous studies, was designed to examine the ability of layers to meet their nutrient requirements by self-selecting from whole maize, protein meal and oyster-shell grit in a single feeder compared with birds fed a complete meal diet at an environmental temperature of 32°C.

Experimental hypothesis and design

The hypothesis developed was that at 32°C the hens' energy intake would decline, but that in those birds, which were choice-fed, the intake of protein and Ca would be maintained, and that as a consequence there would be little change in their egg production at a high temperature. The experimental design was randomised treatments given to individually caged hens in two replicate controlled environment rooms.

Materials and Methods

Birds and feeds

Seventy-six 34-week-old light hybrid pullets of White Leghorn x Australorp genotype (Tegel Tint, Hy-Line 300) were used in this experiment. The experiment consisted of two treatment groups of 38 hens each. The birds had been weighed, leg-banded and trained to choice feeding from 12 weeks in two rooms in the John Hammond Animal Climate Laboratory, The University of New England, Armidale, NSW 2351 Australia. The birds had been used for a choice-feeding experiment for 8 weeks (Henuk *et al.*, 2001). At 32 weeks of age, the birds were re-weighed and re-randomised on the basis of body weight and also randomly re-allocated to one of the two rooms and one of the two feeding regimes. Both rooms were air-conditioned at 32 □ 1°C ('warm for chickens' or 'high for layers'; Henuk *et al.*, 2000), and in each room replicates of 19 birds were fed *ad libitum* on either diet A (Table 1), or diet B (Table 2) which provided for self-selection from a single feeder from a mixture of 67.7% whole maize, 24.0% of the protein meal used in diet A (but without any limestone), and 8.3% oyster-shell grit (the same proportions as in diet A). The protein meal mixture was mixed by machine and the maize meal used in the complete diet was machine-ground. The ME values of the diets were calculated using published values for the basic nutrient composition of normal commercial

poultry feedstuffs (Leeson and Summers, 1991). Birds fed the choice-fed diet (diet B) were provided with granite grit *ad libitum* in an additional feeder fitted at the front of each cage. Insoluble grit such as this is required by birds in order to maintain normal function of the gizzard as a grinding machine and maximize the value of their feed (Balloun and Phillips, 1956; Karunajeewa and Tham, 1984; Henuk and Dingle, 2002a,b).

Data

All basic procedures and performance data collected in this experiment were the same as described by Henuk (1995) and Henuk *et al.* (2000; 2001). All data were subjected to analysis for a complete factorial experiment according to the procedure described by Burr (1982).

Table 1. Composition of the complete diet (diet A) used in the experiment.

Ingredient	Composition (%)
Maize meal	67.7
Soybean meal (45% CP)	11.2
Sunflower meal (38% CP)	10.1
Dicalcium phosphate	1.9
Limestone	8.3
DL-Methionine	0.1
Lysine HCl.	0.2
Salt	0.3
Layer vitamin	0.1
Layer mineral	0.1
Tryptosyne	0.004
T o t a l	100.004
Calculated analysis	
Protein (% CP)	16.5
Energy (MJ/kg)	11.4
Ca (%)	3.5

Table 2. Composition of the three feed components (diet B) used in the experiment.

Ingredient	Composition (%)
(1) Whole maize (Leeson and Summers, 1991)	
Protein (% CP)	8.6
Energy (MJ/kg)	13.9
Ca (%)	0.01
(2) Protein meal	
Soybean meal (45% CP)	11.2
Sunflower meal (38% CP)	10.1
Dicalcium phosphate	1.9
DL-Methionine	0.1
Lysine HCl.	0.2
Salt	0.3
Layer vitamin	0.1
Layer mineral	0.1
Tryptosyne	0.004
T o t a l	24.004
Calculated analysis	
Protein (% CP)	16.5
Energy (MJ/kg)	11.4
Ca (%)	3.5
(3) Oyster-shell grit (Leeson and Summers, 1991)	
Protein (% CP)	-
Energy (MJ/kg)	-
Ca (%)	38.0

Results and Discussion

The treatment means and results of the statistical analyses for the duration of the experiment are summarised in Table 3. There were no significant differences ($P>0.05$) between the hens' intakes of grain, protein meal, oyster-shell grit, total feed and FCR, nor consequently their intakes of ME, protein and Ca. Over the 10-week laying period, the feeding treatments had no significant effect ($P>0.05$) on the hens' performance characteristics except that the choice-fed birds laid more ($P<0.01$) eggs of a larger ($P<0.01$) size, and gained more ($P<0.05$) in body weight, than those fed the complete diet.

Table 3. Effects of environmental temperature and feeding treatments on individual daily intakes and production parameters of hens from 34 to 44 weeks of age

Parameter	32°C		
	Choice feeding	Complete diet	Significance for difference
Grain intake (g/hen/d)	78.4[1)]	78.3[2)]	NS[a)]
ME intake (kJ/hen/d)	1406	1405	NS
Protein sources (g/hen/d)	27.8	27.8[3)]	NS
Protein intake (g/hen/d)	19.1	19.1	NS
ME : protein intake ratio	73.6	73.5	-
Shell-grit intake (g/hen/d)	9.6	9. 6[4)]	NS
Ca intake (g/hen/d)	3.6	3.6	NS
Total feed intake (g/hen/d)	115.8	115.7	NS
FCR (g/g)	2.46	2.51	NS
Egg production (%)	82.8	81.9	**
Egg weight (g)	56.8	56.3	**
Haugh units	99.4	99.3	NS
Yolk colour (Roche Fan)	11.5	11.6	NS
Egg-shell thickness (μm)	342.5	342.7	NS
Egg specific gravity (g/cc)	1.078	1.078	NS
Body weight (g)	1711	1685	*

[1)]whole maize; [2)]calculated value of 67.7% maize meal in the complete diet; [3)]estimate based on protein sources in the complete diet; [4)]estimate based on Ca source in the complete diet; NS[a)] indicates contrast was not significant;**P<0.01; *P<0.05

Discussion

It is of interest to note that hens offered choice feeding *ad libitum* in a single feeder at 32°C did not show a marked drop in total feed intake compared to those fed the complete diet. These results agree well with the previous short-term study of Blake *et al.* (1984). Hens given either feeding treatment in the present study consumed the same amounts of ME, protein and Ca. The birds on either treatment-consumed protein within the range of 18 to 20 g/d recommended by NRC (1994) and Ca within the range of 3.0 to 3.8 g/d recommended by ARC (1975). This report demonstrates that hens, when given the opportunity to learn how to self-select a diet at an early age, can balance their nutrient intakes to equal those consumed in a mixed ration at high temperatures. These results obtained over the 10-week laying period in this study agree well with our previous study (Henuk *et al.*, 2000). However, the nutrient intake and egg production was less in this experiment at 32°C than in the previous one using the same birds at 20°C (Henuk *et al.*, 2001). Other authors (e.g. Blake *et al.*, 1984) have fed three diets, each being high in energy, protein or Ca, by way of self-selection and have reported unsatisfactory hen performance. However, these researchers did not train their birds to recognize these diets before the experiment started, while in the current study hens were trained to choice feeding from 12 weeks of age.

From consideration of egg numbers and egg weights, Scott and Balnave (1985) suggested that the hen's primary goal was to attain a level of egg production and egg weight sufficient to ensure reproductive success. This could be achieved by either obtaining the necessary nutrients through consumption of feed or by mobilising nutrients stored as body tissue. This suggestion may explain why the choice-fed hens in the present study were able to lay more eggs of larger size; while at the same time they gained more body weight than those fed a complete diet (Table 3). A likely cause of the increase in body weight of choice-fed hens appears to be related to the form of grain used in the experiment, since Karunajeewa (1978) indicated that hens given whole grain were able to utilise ME more efficiently, and thus gain more body weight, than those given ground grain in mash diets. In a later study, the author and his co-worker also reported that laying hens offered whole-wheat gain more weight than those offered the crushed grain (Karunajeewa and Tham, 1984). Henuk *et al.* (2000) also found that laying hens offered whole wheat, protein concentrate pellet and oyster-shell grit on a free-choice basis in a single feeder at environmental temperatures of 32□C gained more weight than those offered the complete diet.

The current results contrast with those of Blake *et al.* (1984), who found that hens on choice feeding gained less body weight than those fed a complete diet at high temperatures because in that case hens utilised their body reserves to maintain egg production and egg weight. Such difference in results between experiments may be due to different experimental approaches, or to variations in the duration of training the birds to recognise their diets, and in the duration of each study. In their study, for example, Blake *et al.* used three diets, each being high in energy, protein and Ca. These diets were provided *ad libitum* for laying hens in three feeders for an experimental period of 28 days (compared to one feeder and 70 days in the current work).

In general, the results of this study support those of Scott and Balnave (1988), who concluded that when feed is limited at high temperatures, hens trained to self-select nutrients from separate energy- and protein-rich feed, are better able to sustain egg output and body weight than those fed compete diets.

Conclusion

Laying hens allowed to self-select nutrients from whole maize, protein meal and oyster-shell grit, provided *ad libitum* in a single feeder in a 32°C environmental temperature, were able to lay more eggs of larger size and gained more body weight, while maintaining similar total feed intake, FCR, ME intake, protein intake, Ca intake, Haugh Unit, yolk colour, egg-shell thickness and egg specific gravity compared to laying hens fed a complete, meal diet.

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