The interaction of dietary lysine and temperature on egg laying performance of broiler breeders

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ABSTRACT: The objectives of the present experiment were first to examine and explain the effects of two different ambient temperatures 21°C and 32°C on the response of the egg laying performance; total egg mass output, egg weight and egg number of the broiler breeders. Second, to examine the response of four dietary lysine concentrations (40, 52.5, 65 and 90 g/kg crude protein). Third, to examine whether there were temperature x lysine concentration interactions in the responses of the broiler breeders. Two hundred and twenty-four 34-week old hens (308 Broiler Breeder**)** were randomly placed in one of 16 identical floor pens within four environmentally controlled rooms. Two male birds were each also randomly placed in each pen. The relationship between the lysine concentrations and the egg laying performance variables were compared by regression analysis. A split-plot design was used in which four main plots (rooms) were kept at one of two constant temperatures throughout the whole experimental period. Within each main plot, four sub-plots (pens) were fed each of the four different diets each for a 28 day period. The diet received by each pen in each of four 28 day periods was arranged in a latin-square design. increasing lysine concentration gave a linear increase in egg weight(P=0.017). There were no (P>0.05) effects of temperature on total egg mass output, egg weight or egg number. There were no consistent (P>0.05) temperature x lysine concentration interactions.

Key words: Broiler breeders, egg laying performance, lysine, temperature

INTRODUCTION

Kuwait has high chicken meat consumption (51 kg/person/year). Although Kuwait is still among the leading importers of chicken meat, there has been a recent trend to increase national production. In the past five years, chicken meat production in the region has increased by 33% compared to the overall world chicken meat production increase of 18.5%.

Not only has there been an increase in commercial chicken production in Kuwait but also there has been an increase in the production of hatching eggs to supply this industry. Hatching eggs can be imported to the region but national production gives a number of advantages of vertical integration to the poultry meat production companies.

Management of broiler breeder flocks in Kuwait has some major problems: First, although cereals can be produced in the region, a large proportion of protein concentrates must be imported to be included in the feeds. Proteins and particularly limiting amino acids therefore have a relatively high unit price. Second, there are very high ambient temperatures in many of the main poultry producing areas of the region that must be overcome and understood to enable efficient hatching egg production.

Hatching egg production in Kuwait is almost always undertaken in controlled environment buildings. These buildings will incorporate cooling equipment but still optimum environmental temperatures cannot always be maintained. The laying birds will need to endure high ambient temperatures during daylight hours for large parts of the year. Hatching egg producers need information to be able to predict and understand the effects on the birds of these high temperatures in order to be able to evaluate the economic efficiency of further investments in new sites or in further investment in cooling equipment for existing sites.

There are sufficient data that describe the response to temperature of commercial egg laying strains of hens, although there is a lack of a suitable summary of these effects. However, there is a possibility that the responses of laying broiler breeders could be substantially different to that of commercial egg

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layers: Broiler breeders are restrictedly fed yet has a body weight that is over twice that of birds from commercial egg laying strains. There is a need to examine the responses of broiler breeders to different temperatures.

The balance of amino acids in poultry diets is an important criterion that affects economic viability of a poultry enterprise and lysine is one of the first limiting amino acids in broiler breeder diets. Morris (1983) showed that if flocks of laying hens are given increased dietary concentrations of a limiting amino acid then there is a smooth response curve where egg mass output gradually reaches an asymptote. Knowledge of the exact shape of the response curve in egg output of laying poultry to varying levels of an amino acid is important in formulating diets that optimize the economic efficiency of poultry production systems. There were sufficient published data that described this response to the major limiting amino acids in commercial egg-laying strains, although there is a lack of a good summary of these effects. Additionally there is a lack of studies in broiler breeders and it is possible that this strain of chicken may have a different response to amino acid supply to the commercial egg laying strains.

Observations of commercial broiler breeder flocks has suggested that the response to dietary amino acids may be variable. This variability could be related to the ambient temperatures of the birds. Amino acid imbalance results in excess amino acids being oxidised. This metabolic process is relatively inefficient and results in a high heat output (Emmans 1994). The response of birds at high temperatures may differ because of their reduced energy requirements and their inability to dissipate excess body heat. There is a need to examine whether the ideal balance of essential amino acids is different at different ambient temperatures. Many practical broiler breeder feeds are limiting in lysine, so this amino acid may be the most appropriate amino acid to examine first.

The objectives of the present experiment were first to examine and explain the effects of two different ambient temperatures 21 ^{o}C and 32^{o}C on the response of the egg laying performance: total egg mass, egg weight and egg number of the broiler breeders. Second, to examine the response of four dietary lysine concentrations (40, 52.5, 65 and 90 g/kg crude protein). Third, to examine whether there were temperature x lysine concentration interactions in the responses of the broiler breeders.

MATERIALS AND METHODS

Experimental Treatments

Feed: A single lysine deficient diet that contained 158 g/kg crude protein (*Table1*) was formulated based on wheat . The concentration of all other amino acids and nutrients met or exceeded the requirements of the broiler breeder hens according to National Research Council (1994) and Ross Breeders Limited (1998). Three further dietary levels of lysine concentration were achieved by adding lysine-HCl to the deficient diet in replacement for maize starch, to give four dietary concentrations of lysine (40, 52.5, 65 and 90 g/kg crude protein).

Birds: Two hundred and twenty-four 34-week old hens (308 Broiler Breeder, Ross Breeders Ltd., Newbridge, Midlothian, Scotland) were randomly placed in one of 16 identical floor pens within four environmentally controlled rooms. Two male birds were each also randomly placed in each pen. A daily feed restriction programme was followed, 150 g/bird d then a reduction of 2.5 g/ bird / 28 d period (Ross Breeders Limited 1998). After the completion of each period in the experiment, the diet was changed and a new diet introduced for the next period in the experiment.

Temperature: There were two different temperatures used in the experiment (21 ^{o}C and 32^{o}C). Each room was randomly allocated a temperature at the beginning of the experiment and kept at this temperature until the completion of the whole experiment. Relative humidity was kept in the range of 70-75%.

Experimental Measurements

Total egg numbers were recorded daily during the experiment. All the eggs were weighed and egg mass output was calculated for each pen of broiler breeders.

Table 1. Composition of the broiler breeder lysine deficient diet fed in the experiments.

Ingredients	Lysine deficient diet, kg†‡
Wheat	680.0
Maize gluten meal (600g/kg CP)	68.0
Sunflower meal (330 g/kg protein)	83.0
Full fat soya	20.0
Maize starch	18.9
Soya oil	10.0
Limestone	80.0
Dicalcium phosphate	10.0
Sodium bicarbonate	2.0
Salt	2.0
DL-methionine	2.8
L-threonine	1.7
L-tryptophan	1.6
Vitamin-Mineral Supplement$	20.0
Total	1000.0
Nutrient Composition:	
Determined chemical analysis	
Crude Protein (CP) (g/kg)	158.0
Lysine (g\kg CP)	40.0
Methionine (g\kg CP)	32.0
Tryptophan (g\kg CP)	17.2
Methionine+ Cystine (g\kg CP)	49.5
Threonine (g\kg CP)	41.5
Isoleucine (g\kg CP)	40.0
Arginine (g\kg CP)	65.5
Valine (g\kg CP)	48.0
Histidine (g\kg CP)	23.0
Calculated analysis	
Metabolisable Energy (MJ/kg)	11.6
Calcium (g\kg)	37.5
Phosphorus (g\kg)	5.2
Sodium (g\kg)	1.8
Potassium (g\kg)	4.3
Linoleic acid (g\kg)	14.0
Choline (mg\kg)	1100

† The other 3 experimental diets included additional (L-lysine HCl) in replacement for maize starch.
‡ The other 5 experimental diets included additional (L-lysine HCl) in replacement for maize starch.
$Supplied per kg of diet: *trans*-retinol(A), 4.8 mg; cholecalciferol(D3), 125μg; α-tocopherol acetate(E), 183.8 mg; thiamine(B1), 3 mg; riboflavin(B2), 10 mg; pyridoxine(B6), 5 mg; vitamin B12, 12 mg; nicotinic acid, 60 mg; pantothenic acid, 15 mg; folic acid, 2.5 mg; biotin, 205 μg; choline chloride, 500 mg; Fe, 20 mg; Co,1 mg; Mn, 100 mg; Cu, 10 mg; Zn, 80 mg; I, 2 mg; Se, 0.2 mg; Mo, 0.5 mg; Ca, 206g/kg; P, 100.5g/kg; Na, 50g/kg; Ash , 882g/kg.

Statistical Analysis

A split-plot design was used in which four main plots (rooms) were kept at one of two constant temperatures throughout the whole experimental period. Within each main plot, four sub-plots (pens) were fed each of the four different diets each for a 28 day period. The diet received by each pen in each of four 28 day periods was arranged in a latin-square design. Data were compared by analysis of variance of the measured and calculated variables using a split-plot design that examined the temperature, dietary lysine concentration and the diet x temperature interactions (*GENSTAT* statistical package, Lawes Agricultural Trust, 1998). The treatment sums of squares of the dietary lysine concentrations were partioned into their linear and non-linear (quadratic) effects. Egg fertility data were not normally distributed so an arcsine transformation was applied prior to statistical comparison of the treatment effects.

RESULTS AND DISCUSSION

Throughout the experiment the allocated amounts of feed were always eaten. The mean mortality during the experiment was 2.3% (6 birds in total), which was not associated with particular treatments. The overall mean egg output of the flock was low relative to commercial standards but this was probably a reflection of the experimental treatments applied.

Increasing lysine concentration gave a linear increase in egg weight(P=0.017). There were no (P>0.05) effects of temperature on total egg mass output, egg weight or egg number(Table 2). There were no consistent (P>0.05) temperature x lysine concentration interactions.

Table 2. Effects of four dietary lysine levels on egg laying performance; total egg mass output, egg weight and egg number of broiler breeders (33- 49 weeks of age) kept at 21 or 32 ^{o}C.

Temperatures, ^{o}C	Variables	Lysine concentrations, g/kg Crude Protein				Mean temperature effects
		40	52.5	65	90	
21	Egg mass, g/hen/d	31.84	35.40	30.84	33.30	32.85
	Egg weight, g/d	64.06	64.72	65.07	65.29	64.79
	Egg number, no/hen/d	0.50	0.55	0.47	0.51	0.51
32	Egg mass, g/he /d	30.03	31.36	28.25	32.40	30.48
	Egg weight, g/d	61.91	62.85	63.19	66.12	63.51
	Egg number, no./hen /d	0.49	0.50	0.45	0.49	0.48
	Mean lysine concentration effects					
	Egg mass, g/hen/d	30.92	33.36	29.50	32.85	
	Egg weight, g/d	62.98	63.79	64.13	65.70	
	Egg number, no/hen/d	0.49	0.52	0.46	0.50	

	Statistical significance and SEM of treatment means					
	Temperature (*n*=2)		Lysine (*n*=16)		Temperature x lysine interaction (*n*=8)	
	P	SEM	P	SEM	P	SEM
Egg mass, g/hen/d	P>0.10	1.985	P>0.10	1.411	P>0.10	2.632
Egg weight, g/d	P>0.10	0.571	Linear (P=0.017)	0.797	P>0.10	1.131
Egg number, no./hen/d	P>0.10	0.027	P>0.10	0.023	P>0.10	0.038

The objectives of this experiment were to examine the effects on egg laying performance of four diets that differed in their lysine concentrations (40, 52.5, 65 and 90 g/kg crude protein) fed to broiler breeders when kept at two ambient temperatures (21 and 32^{o}C).

The experiment demonstrated that increasing dietary lysine concentrations increased (P=0.017) the mean egg weights from the broiler breeders although there were no significant effects (P>0.05) effects of temperature on total egg mass output, egg weight or egg number. The amino acid levels in the feeds were monitored during the feed formulation and throughout the experimental period. It does therefore appear that lysine was the limiting amino acid in the experimental diets and that there was only a small egg weight response to differences in lysine supply. The difference between the dietary lysine responses of the broiler breeders in the present experiment agrees with the data of Karunajeewa (1974) and Bowmaker and Gous (1991).

The feed intakes of the broiler breeders were restricted in the present experiment and all pens ate their feed allocations. It may be that the larger egg weight responses of egg laying strains were due to differences in feed intakes with increasing lysine concentrations. The egg mass outputs of the broiler breeders were also much lower as a proportion of daily feed intake and body mass compared to egg layer strains.

The relatively small dietary lysine effects on the egg production characteristics of the breeder hens were not expected. The different dietary lysine concentrations were given to the pens of breeder hens for 28 day periods. It may be that a longer feeding period may have given a larger effect on the egg weight and egg mass output of the breeders.

This present experiment demonstrated differences between the two temperature treatment groups that were consistent with the previous experiment. The numerical differences in egg mass output and mean egg weight was not, however, demonstrated to be statistically significant. This experiment had only two replicate rooms for each temperature so it was unlikely that statistically significant differences would be demonstrated.

CONCLUSIONS

This experiment has confirmed the effect of different ambient temperatures on the hatching egg production of broiler breeders. Increasing dietary lysine increased egg weights. The responses were small relative to published responses of egg-laying strains.

LITERATURE CITED

Bowmaker, J.E. and Gous, R.M. (1991) The response of broiler breeder hens to dietary lysine and methionine. British Poultry Science 32: 1069-1088

Chi, M. S. and Speers, G. M. (1976) Effects of dietary protein and lysine levels on plasma amino acids, nitrogen retention and egg production in laying hens. Journal of Nutrition 106: 1192-1201

Emmans, G.C. (1994) Effective energy. British Journal of Nutrition 72: 214-233

Ingram, G. R., Cravens, W.W., Elvehjem, C.A. and Halpin, J.G. (1950) Relation of tryptophan and lysine to egg production, hatchability and composition of the protein of hens' eggs. Poultry Science 29: 793-803

Karunajeewa, H. (1974) The effect of methionine and lysine supplements on the performance of broiler-breeder hens. The Journal of the Australian Institute of Agricultural Science 40: 298-300

Morris, T. R. (1983) The interpretation of response data from animal feeding trial. In: Recent Advances in Animal Nutrition (Haresign, W., Ed),Butterworths,London pp.13-23

Prochaska, J. F., Carey, J. B. and Shafer, D. J. (1996) The effect of L-lysine intake on egg component yield and composition in laying hens. Poultry Science 75: 1268-1277

Ross Breeders Limited (1998) Ross 308 Parent Stock Management Manual, Newbridge, Midlothian, Scotland

wilson, H.R. and Harms, R.H. (1984) Evaluation of nutrient specifications for broiler breeders. Poultry Science 63: 1400-1406