Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola

ISSN 1516-635X Aug - Oct 2011 / v.13 / n.3 / 207-210

Performance of Layers Submitted to Different Forced-Molting Methods and Different Temperatures[1]

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[1] Study funded by Fapesp. Processes n: 07/555970-3 and 07/56447-2.

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Keywords

Egg quality, heat stress, performance, welfare.

ABSTRACT

This study was carried out to evaluate the performance and egg quality of laying hens, in their second laying cycle submitted to different forced-molting methods and three environmental temperatures. Six hundred layers were distributed in a completely randomized experimental design with 15 treatments with five replicates of eight birds each, according to 5x3 factorial arrangement (molting methods *vs*. temperatures). The following forced-molting methods were applied: 90%, 70%, 50% dietary alfalfa inclusion, addition of 2,800 ppm zinc, and feed fasting. Temperatures were: 20 °C, 27 ºC and 35 ºC. At the end of each period of the second laying cycle, bird performance and egg quality were evaluated. Data were submitted to analysis of variance and means were compared by orthogonal and polynomial contrasts. The highest alfalfa inclusion level (90% alfalfa and 10% basal diet) proved to be efficient as compared to the other methods, independently of temperature.

INTRODUCTION

Eggshells present reduced thickness and strength by the end of the first laying cycle, precisely when eggs become heaviest. Forced molting is an economically viable management practice to solve this problem by causing stress, making hens to stop laying (Roland & Brake, 1982).

Forced molting methods include feed and water fasting, light restriction, and chemical agents. Feed withdrawal from the feeders for 10 to 12 days is the easiest method to induce molting in layers (Donalson *et al*., 2005).

However, despite its good results and easy application, feed fasting is subject of animal welfare concerns due to its aggressiveness of feed fasting, and therefore, less stressful forced-molting methods, such as the dietary inclusion of insoluble fibers, have been investigated (Donalson *et al*., 2005; Landers *et al*., 2005; Kwon *et al*., 2001).

Studies on alternative forced-molting methods have yielded conflicting results due to the variations of responses of birds kept under different environmental conditions. Among the environmental factors, thermal conditions, represented by temperature, humidity, and air movement, have a direct effect on birds, as these not allow birds to maintain constant body temperature (Tinoco, 1995). At temperatures higher than 30 °C, feed intake rapidly drops and energy requirements increase, as birds need to eliminate heat, leading to worse performance (Furlan & Macari, 2002).

Taking these facts into consideration, this study aimed at evaluating the performance and egg quality of commercial layers in their second laying cycle after being submitted to different forced-molting methods

MATERIALS AND METHODS

The experimental period included the phases of forced molting, resting, and second laying cycle (six periods of 28 days). Birds were selected as a function of body weight and egg production.

In the trial, 600 72-week-old Isa Brown® commercial layers were distributed into 75 experimental units according to a completely randomized experimental design in a 5x3 factorial arrangement (forced-molting method x temperature), with five replicates of eight birds each.

During the forced-molting period, a lighting regime of 12 hours of light/day was adopted. During the resting period, the number of hours of light was increased up to 17 hours of light/day. Feed and water were supplied *ad libitum*.

Birds were kept in three climatic chambers during the forced-molting period (14 days) and the resting period (28 days), where temperature and maximum and minimum humidity were measured using hygro-thermometers. During the second laying cycle, birds were housed in a conventional layer house.

Five methods of forced-molting were applied: 90% alfalfa and 10% feed (A90); 70% alfalfa and 30% feed (A70); 50% alfalfa and 50% feed (A50); feed with the addition of 2,800 ppm zinc (Zn) and feed fasting (control).

The following temperatures were applied: cold temperature (CT): 20 °C; thermoneutral temperature (NT): 27 °C; hot temperature (HT): 35 °C.

During the second laying cycle, at the end of each period, the following performance parameters were evaluated: feed intake, egg production, average egg weight (total egg weight divided by the number of eggs produced in each experimental unit), egg mass (egg production percentage multiplied by respective average egg weight) and feed conversion ratio (kg feed/kg eggs and kg feed/dozen eggs). Egg quality was evaluated as to Haugh units (100 log (h + 7.57 – 1.7 $W^{0.37}$), where h = albumen height in mm and W = egg weight in grams and eggshell percentage and thickness. Egg specific gravity was determined using different NaCl solutions with densities between 1.065 and 1.100 g/cm³ in 0.005 increments, according to the recommendations

formulated according to the recommendations of Rostagno *et al*. (2005). Feed ingredient composition is shown in Table 1 and the nutritional composition in Table 2.

Table 1 – Ingredient composition of the experimental diets.

Ingredients (%)	Basal feed		2nd laying cycle
	Molting	Resting	
Ground corn	72.80	72.32	59.65
Soybean meal 45%	23.60	23.60	26.07
Limestone	1.54	1.54	9.80
Dicalcium phosphate	1.43	1.43	1.46
Mineral and vitamin supplement*	0.50	0.50	0.50
Salt	0.02	0.50	0.50
DL-methionine	0.11	0.11	0.12
Soybean oil	-	-	1.90
Total	100	100	100

*Enrichment per kg feed: 7,812 IU vitamin A, 3,125 IU vitamin D_3, 15.6 mg vitamin E, 1.2 mg vitamin K_3, 1.9 mg vitamin B1, 4.3 mg vitamin B_2, 1.2 mg vitamin B_6, 25 mcg vitamin B_{12}, 0.3 mg folic acid, 0.1 mg biotin, 12.4 mg niacin, 0.06 mg calcium pantothenate, 9.4 mg copper, 0.8 mg iodine, 57.2 mg manganese, 75.3 mg zinc, 0.3 mg selenium, 0.3 g choline chloride 50%, 1.8 g methionina, 62.5 mg growth promoter, 0.5 mg antioxidant.

Table 2 – Nutritional composition of the experimental diets.

	Molting*				Resting	2nd laying cycle
	A90	A70	A50	Zn		
Metabolizable energy (kcal/kg)	1.184	1.592	2.000	3.025	3.008	2.800
Crude protein (%)	17.00	17.00	17.00	17.00	17.00	17.00
Crude fiber (%)	22.82	18.45	14.09	-	-	-
Calcium(%)	1.270	1.210	1.150	1.020	1.020	4.200
Avail. phosphorus (%)	0.110	0.170	0.230	0.380	0.380	0.380
Total phosphorus (%)	0.267	0.341	0.415	0.603	0.602	0.591
Sodium (%)	0.077	0.071	0.065	0.050	0.230	0.230
Total lysine (%)	0.796	0.808	0.820	0.855	0.856	0.892
Dig. lysine (%)	0.595	0.645	0.695	0.816	0.818	0.859
Total methionine (%)	0.264	0.292	0.320	0.389	0.390	0.399
Dig. methionine (%)	0.218	0.254	0.290	0.376	0.377	0.390
Total Met+Cys (%)	0.466	0.518	0.570	0.698	0.698	0.698
Dig. Met+Cys (%)	0.428	0.484	0.540	0.680	0.680	0.680
Total threonine (%)	0.733	0.718	0.703	0.658	0.658	0.658
Dig. threonine (%)	0.630	0.490	0.350	0.570	0.570	0.572
Total tryptophan (%)	0.258	0.234	0.210	0.151	0.151	0.166
Dig. tryptophan (%)	0.230	0.210	0.190	0.137	0.137	0.150

* A90 = 90% alfalfa and 10% feed; A70 = 70% alfalfa and 30% feed; A50 = 50% alfalfa and 50% feed; Zn = feed with the addition of 2,800 ppm zinc.

The obtained data were submitted to analysis of variance using the General Linear Model (GLM) of SAS® statistical package (SAS Institute, 2002). When significant effects were determined, means were compared at 5% probability level by orthogonal and polynomial contrasts, as follows: contrast 1 –

contrast 2 – linear effect of alfalfa levels; contrast 3 – quadratic effect of alfalfa levels; contrast 4 – comparison between Zn and feed fasting means; contrast 5 –linear effect of temperatures; contrast 6 – quadratic effect of temperatures.

RESULTS AND DISCUSSION

Means, coefficients of variation, F values of analysis of variance, and orthogonal and polynomial contrasts of performance parameters evaluated during the second laying cycle are shown in Table 3.

There was a decreasing linear behavior ($p < 0.05$) of egg mass as a function of the temperatures in which birds were maintained during the periods of forced-molting and resting. Temperature increases affect feed intake, egg production and feed conversion ratio (Teeter, 1989), and low egg weights are directly related with lower feed intake (Andrade *et al.*, 1976). Layers submitted to heat stress present lower egg production and egg mass (Njoya & Picard, 1994; Mashaly *et al.*, 2004) as compared to those maintained in thermal comfort.

Treatments did not influence the other performance parameters evaluated ($p > 0.05$).

Table 3 – Performance parameter values of layers evaluated during the second laying cycle.

Treatment[2]	Evaluated parameter[1]					
	FI (g/hen/day)	REP (%/hen/day)	EW (g)	EM (g/day)	FCR (kg/dz)	FCR (kg/kg)
Forced-molting methods (FMM)						
A90	110.10	73.73	71.33	52.43	1.80	2.12
A70	109.03	67.89	71.54	48.51	2.03	2.36
A50	114.85	74.83	71.25	53.36	1.87	2.20
Zn	111.82	75.21	72.81	54.75	1.81	2.08
Feed fasting	112.93	77.38	70.01	54.06	1.79	2.13
Temperatures (T)						
CT	112.99	77.22	71.65	55.41	1.79	2.09
NT	113.66	75.03	72.00	53.94	1.86	2.16
HT	108.58	69.17	70.51	48.52	1.92	2.28
F values of the analysis of variance						
Molting	0.98^{NS}	1.03^{NS}	0.67^{NS}	1.01^{NS}	1.91^{NS}	1.87^{NS}
Temperature	2.35^{NS}	2.34^{NS}	0.68^{NS}	3.68*	1.45^{NS}	2.32^{NS}
FMM x T interaction	0.85^{NS}	1.05^{NS}	0.28^{NS}	1.08^{NS}	1.45^{NS}	1.39^{NS}
CV(%)	6.24	14.28	5.11	13.93	11.39	11.18
F values of the contrasts[3]						
C5	-	-	-	6.64*	-	-
C6	-	-	-	0.73^{NS}	-	-

NS – not significant, * - $p < 0.05$. 1 - FI = feed intake, REP = relative egg production, EW = average egg weight, MO = egg mass, FCR = feed conversion ratio. 2 - A90=90 % alfalfa and 10 % feed, A70 =70% alfalfa and 30% feed, A50=50% alfalfa and 50% feed, Zn=feed with zinc oxide; CT=cold temperature; NT=thermoneutral temperature; HT=hot temperature. 3 – C5=linear effect of temperature and C6=quadratic effect of

Means, coefficients of variation, F values of analysis of variance, and orthogonal and polynomial contrasts of egg quality characteristics evaluated during the second laying cycle are shown in Table 4. The lowest alfalfa inclusion levels resulted in a linear decrease ($p < 0.05$) of Haugh units. Donalson et al. (2005), in a similar experiment, using different alfalfa dietary inclusion levels to induce molting, observed higher albumen height values (a characteristic directly related to Haugh units) in hens fed lower alfalfa levels as compared to the other treatments

Eggshell percentage, eggshell thickness, and egg specific gravity did were not influenced by the treatments ($p > 0.05$).

CONCLUSIONS

Increasing temperatures reduced egg mass; however, the evaluated forced-molting methods and temperatures to which the birds were submitted did not

Table 4 – Egg quality characteristics evaluated during the second laying cycle.

Treatment[2]	Evaluated characteristic[1]			
	HU	ESP (%)	EST (mm)	SG (g/cm^3)
Forced-molting methods (FMM)				
A90	86.42	8.74	0.348	1.084
A70	83.58	8.61	0.345	1.083
A50	83.10	8.81	0.348	1.083
Zn	86.44	8.79	0.355	1.085
Feed fasting	85.44	8.60	0.344	1.082
Temperatures (T)				
CT	84.73	8.71	0.344	1.083
NT	86.05	8.69	0.349	1.084
HT	84.21	8.73	0.351	1.084
F values of the analysis of variance				
Molting	2.95*	0.60^{NS}	0.67^{NS}	1.42^{NS}
Temperature	1.77^{NS}	0.04^{NS}	1.02^{NS}	1.91^{NS}
Interaction FMM x T	1.42^{NS}	1.25^{NS}	0.80^{NS}	1.34^{NS}
CV(%)	3.24	4.40	4.39	0.24
F values of the contrasts[3]				
C1	3.54^{NS}	-	-	-
C2	6.58*	-	-	-
C3	1.10^{NS}	-	-	-
C4	0.59^{NS}	-	-	-

NS – not significant, *$p < 0.05$. 1 - UH = Haugh units, ESP = eggshell percentage, EST = eggshell thickness, and SG = specific gravity. 2 - A90=90% alfalfa and 10% feed, A70 =70% alfalfa and 30% feed, A50=50% alfalfa and 50% feed, Zn=feed with zinc oxide; CT=cold temperature; NT=thermoneutral temperature; HT=hot temperature. 3 - C1= alfalfa treatment means versus zinc and fasting means; C2=linear effects of alfalfa levels; C3= quadratic effects of alfalfa levels; C4=comparison between zinc and feed fasting; C5=linear effects of temperatures and C6=quadratic effects influence the other performance parameters. The method using the highest alfalfa inclusion level (90% alfalfa and 10% feed) was more efficient, relative to egg quality, than the other alfalfa inclusion levels, independently of temperature.

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