DIET MANAGEMENT ASSOCIATED WITH DIFFERENT TEMPERATURES FOR INDUCING MOLT IN LAYING HENS[1]

MANIPULAÇÃO DA DIETA ASSOCIADA A DIFERENTES TEMPERATURAS PARA AVES DE POSTURA EM MUDA FORÇADA[1]

S. SGAVIOLI; R. S. FILARDI; M. F. F. M. PRAES; C. H. F. DOMINGUES; I. C. BOLELI; O. M. JUNQUEIRA

SUMMARY

This study evaluates the performance of laying hens during molt subjected to different diets and temperatures. The birds were distributed in a completely randomized design, 5x3 factorial (diet x temperature), with five replicates of eight birds each. The diets tested to induce molt were: 90%, 70%, 50% alfalfa; added of 2,800 ppm of zinc while the last group was on full feed restriction. The temperatures used were: 20, 27 and 35ºC. Performance parameters of the birds were evaluated during the process of molt and rest. The data underwent analysis of variance by SAS® and means were compared using orthogonal and polynomial contrasts. The results indicated that diets including alfalfa induced molt in laying hens at 3.85 days after being fed. The birds fed alfalfa had weight loss of 26.88% in order to induce molt compared to 30.26% for the birds of the control group (fasting). Egg production of birds kept at neutral temperature during molt ceased at 2.73 days, earlier than the other temperatures studied. Furthermore, birds kept at warmer temperatures (10.47 days) during molt and rest returned earlier to posture while greater body weight recovery was observed at this temperature for birds fed diets containing 50% alfalfa (35.66%). The alfalfa inclusion can be used as an alternative to fasting to cause a weight loss sufficient to induce molt, independent of temperature.

KEY-WORDS: Alfalfa. Body weight. Fasting. Fiber. Heat stress.

RESUMO

O objetivo do estudo foi avaliar o desempenho de poedeiras comerciais durante a muda forçada submetidas a diferentes dietas e temperaturas. As aves foram distribuídas em um delineamento inteiramente ao acaso, em esquema fatorial 5x3 (dietas x temperaturas), com cinco repetições de oito aves cada. As dietas testados consistiram de inclusão de alfafa, em 90%, 70% e 50%, dieta com 2.800 ppm de zinco e o controle jejum alimentar. As temperaturas utilizadas foram: 20 ºC, 27 ºC e 35 ºC. As deitas foram fornecidas durante 14 dias. Durante o processo de muda e descanso, foram avaliadas as características de desempenho das aves. Os dados obtidos foram submetidos à análise de variância pelo programa SAS ® e as médias comparadas por meio de contrastes ortogonais e polinomiais. Os resultados indicaram que dietas com a inclusão de alfafa induziram o processo de muda em poedeiras comerciais em 3,85 dias após o fornecimento. As aves arraçoadas com alfafa apresentaram perda de peso corporal para induzir a muda de 26,88%, enquanto que para o controle (jejum alimentar) a perda de peso corporal foi de 30,26%. Aves mantidas em temperatura termoneutra, durante a muda, cessaram a produção de ovos em 2,73 dias, antes das aves mantidas nas demais temperaturas, além disso, o retorno da postura foi mais breve para aves mantidas em temperatura quente (10,47 dias) durante a muda e o descanso, com uma maior recuperação do peso corporal nesta temperatura, para as aves que receberam dietas contendo 50% de alfafa (35,66%). A inclusão de alfafa pode ser utilizada com alternativa ao método de jejum alimentar, causando uma perda de peso corporal suficiente para a indução da muda, independente da temperatura em que for realizada.

PALAVRAS-CHAVE: Alfafa. Estresse por calor. Fibra. Jejum. Peso corporal

[1]* Ph.D. student of Zootecnia. Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal – UNESP. Corresponding author: sarahsgavioli@yahoo.com.br.

INTRODUCTION

Induced molt is a set of practices carried out aiming to induce stress in birds in order to break production (ROLAND & BRAKE, 1982). Molting can be considered a strategy to solve some problems regarding egg quality, such as decreasing thickness and worsening strength of eggshells due to increasing bird weight, usually found at the end of the first laying cycle.

There are a variety of molting methods ranging from food and water fasting, light restriction to the use of chemical agents. The feed withdrawal of the troughs for 10 to 12 days is the simplest method of inducing molts in laying hens (DONALSON et al., 2005).

Currently, molting methods that cause less stress in birds, with the inclusion of insoluble fibers in the diet have been studied (KWON et al., 2001; DONALSON et al., 2005; LANDERS et al., 2005). Lately, great emphasis is placed on animal welfare, and although the most commonly used method of fasting gives satisfactory results and is easy to apply, it is also aggressive.

Among environmental factors, thermal conditions represented by temperature, humidity and air movement, directly affect birds because they can compromise the maintenance of homeothermy (TINOCO, 1995). Above 30°C, food intake decreases rapidly and the energy requirements increase due to the necessity that poultry have of eliminating heat, causing a reduction in performance (FURLAN & MACARI, 2002). No data are found in the literature on how room temperature impacts molting in poultry. Studies of the interaction between diets associated with different temperatures for laying birds are extremely important. Therefore, the present study aimed to evaluate the performance of laying hens during induced molt subjected to different diets and temperatures.

MATERIAL AND METHODS

The experiment consisted of the molting and resting phases. The birds were selected according to body weight and egg production. A total of 600 Isa Brown hens aged 72 weeks were distributed in 75 plots.

The treatments were distributed in a completely randomized design, 5x3 factorial (diet x temperature), with five replicates of eight birds each.

During molting, the hens remained under 12 hours of light/day while during resting, the light was increased to achieve the desired 17 hours of light/day, with food and water offered freely.

The birds remained in three acclimatized chambers, during molting (14 days) and rest (28 days) periods. Temperature and maximum and minimum humidity within the chambers were measured using a thermo-hygrometer.

Five different molting-inducing diets were tested as follows: 1) 90% alfalfa and 10% ration (90% alfalfa); 2) 70% alfalfa and 30% ration (70% alfalfa); 3) 50% alfalfa and 50% ration (50% alfalfa); 4) ration added 2,800 ppm of zinc (zinc); and, 5) control, the birds were subjected to fasting (fasting). The following temperatures were tested: cool temperature (CT) 20ºC, thermoneutral (TN) 27ºC, warm temperature (WT) 35ºC.

During the molting period, the performance parameters evaluated were: feed and metabolizable energy intake, body weight loss, egg production, days to cease laying and production viability ((total number of birds – number of dead birds during molting)/total number of birds x 100).

During the resting period, the performance parameters evaluated were: feed intake, mean egg weight (given by the total eggs weight/ number of eggs obtained per plot), feed conversion (kg feed/dozen eggs), recovery of body weight, egg production, days to return to posture (50-60% egg production) and days to first egg.

Diets were formulated based on corn and soybean meal, according to the recommendations of Rostagno et al. (2005). Table 1 shows the percent composition and calculated nutritional value of the diets.

Data were subjected to analysis of variance by the General Linear Model (GLM) of SAS® (SAS INSTITUTE, 2002). Significantly different means were compared at 5% probability using the orthogonal and polynomial contrasts: contrast 1 - comparison between the sum of the averages of treatments with alfalfa versus the sum of the averages of the other treatments; contrast 2 - linear effect for alfalfa percentages; contrast 3 - quadratic effect for alfalfa percentages; contrast 4 - Comparison between the zinc average and fasting; contrast 5 - linear effect for temperatures; contrast 6 - quadratic effect for temperatures.

RESULTS AND DISCUSSION

Feed and metabolizable energy intake ($p < 0.05$) decreased as the percentage of alfalfa in the diet increased during molting (Table 2). Decreasing feed intake is related to several factors, including birds appetite suppression (MROSOVSKY & SHERRY, 1980), altered taste (SEN et al., 1998), together with reduced photoperiod during the molting period (ANDREWS et al. 1987b). Furthermore, the saponins present in alfalfa may influence the intake of diet with high levels of alfalfa (MATSUSHIMA, 1972). The slow passage rate of alfalfa can also influence feed intake, giving the birds a feeling of satiety and thereby reducing feed intake (SIBBALD, 1979). Ueda et al. (2002) suggested that the lower feed intake of birds fed alfalfa is due to lower passage rate of alfalfa. DONALSON et *al.* (2005) also reported that laying hens treated with 70, 90 and 100% of alfalfa, for inducing molting, had a linear decreasing food intake.

Additionally, birds fed the diet containing zinc oxide also had low feed intake. This reduction in consumption can be explained by appetite suppression

Table 1 - Percent composition and calculated nutritional value of diets in the different phases of the experiment.

Ingredients (%)	Basal diet	
	Molt	Rest
Corn meal	72.80	72.32
Soybean meal 45%	23.60	23.60
Limestone	1.54	1.54
Bicalcium phosphate	1.43	1.43
Vitamin Mineral Supplement*	0.50	0.50
Salt	0.02	0.50
DL-methionine	0.11	0.11
Total	100	100

Calculated nutritional value	Molts **				
	A90	A70	A50	Zn	Rest
Metabolizable energy (kcal / kg)	1,184	1,592	2,000	3,025	3,008
Crude protein (%)	17.00	17.00	17.00	17.00	17.00
Crude fiber (%)	22.82	18.45	14.09	3.59	3.42
Calcium (%)	1,270	1,210	1,150	1,020	1,020
Available phosphorus (%)	0,110	0,170	0,230	0,380	0,380
Total phosphorus (%)	0,267	0,341	0,415	0,603	0,602
Sodium (%)	0,077	0,071	0,065	0,050	0,230
Total lysine (%)	0,796	0,808	0,820	0,855	0,856
Total Methionine (%)	0,264	0,292	0,320	0.389	0,390
Total Met + Cist. (%)	0,466	0,518	0,570	0.698	0.698
Total threonine (%)	0,733	0,718	0,703	0,658	0,658
Total tryptophan (%)	0,258	0,234	0,210	0,151	0,151

* Enrichment per kilogram of diet: 7812 IU vitamin A, 3125 IU vitamin D_3, 15.6 mg vitamin E, 1.2 mg vitamin K_3, 1.9 mg vitamin B_1, 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 50% choline chloride, 1.8 g methionine, 62.5 mg growth promoter, 0.5 mg antioxidant. **A90=90% alfalfa and 10% ration, A70 = 70% alfalfa and 30% ration, A50=50% alfalfa and 50% ration, Zn= 2,800 ppm of zinc added ration.

(BRINK et al., 1950) associated with decreased palatability (FOK, 1989). Feed consumption can also be reduced due to the ability of the zinc (Zn^{2+}) cation to induce follicular atresia and stop egg production (JOHNSON & BRAKE, 1992). Therefore, it is likely that the positive results of zinc supplemented diet, as a method to induce molting (BRAKE, 1993), are directly related to the suppression of food intake, similar to what happened with the alfalfa treatments.

Significant effects ($p < 0.05$) were observed for weight loss between treatments containing alfalfa and others (zinc and fasting) (Table 2). The birds fed diets containing alfalfa had less weight loss than birds from other treatments. Weight loss is an important parameter because it contributes to the success of induced molt due to its impact on reproduction and fatty deposits (PARK et al., 2004). The regression of the reproductive tract is proportional to weight loss while it rejuvenates the reproductive tract and removes fat deposits, thus increasing the efficiency of tissues related to reproduction (ALODAN & MASHALY, 1999). The increase of dietary alfalfa was responsible for these results since with higher energy concentration and lesser alfalfa (50% alfalfa and 50% diet) in the diet, the birds were able to minimize body weight loss while maintaining the functionality of the reproductive tract, and returned sooner to posture (8.56 days) compared with birds fed 70% alfalfa and 30% ration (10.22 days) (Table 3).

However, despite significant differences regarding body weight loss for birds fed with different percentages of alfalfa, the weight loss was greater than 25%. According to Backer et *al.* (1983), a weight loss of 25% is enough to ensure an efficient ovarian regression.

The days to cease posture parameter displayed a quadratic effect ($p<0.05$) with temperatures. The birds that needed the shortest period to cease posture were the ones that remained in thermoneutral environment (Table 2). The sooner the birds cease egg production during the molting period, the faster they will return to production in the rest period while during the second production cycle a shorter time will be needed to reach production peak (NORTH & BELL, 1990) .

Mortality is considered an index of animal welfare and was, therefore, evaluated as such for birds being fed molting diets. In the present study, mortality rates were not significantly different ($p> 0.05$) between treatments (Table 2). Unlike the data reported by Giradon (2011), who studied different diets (soybean hulls, wheat meal, high tannin sorghum and fasting) and reported that mortality rates were significantly lower for birds feeding on alternative feed sources compared to those fasting. However, Giradon (2011) added core to all alternative diets, resulting in a lower nutritional deficiency of birds, a fact that may have contributed to the lower mortality. Therefore, further research is needed to establish the ideal fiber ratio that should be added to the diet to induce molting.

Egg production was not significantly ($p>0.05$) affected by the different treatments and temperatures used (Table 2).

During the rest period, a decreasing linear correlation ($p <0.05$) was observed between feed intake and temperature (Table 3). The results showed that feed intake was lower for birds kept in warm temperatures. As temperature increased, the first behavioral response of birds was to restrict feed intake (HURWITZ et al., 1980), which is consistent with the literature.

Feed conversion improved ($p<0.05$) with increasing temperature (kg/dz eggs) since despite the fact that heat stress reduced feed intake during rest, egg production remained constant.

The return to posture during rest is directly related to the weight loss during molting. Generally, the greater the weight loss during molting, the longer the necessary time to return to posture during rest (ROLAND & BRAKE, 1982). The days necessary to return to posture and 1st egg laying were significantly affected ($p<0.05$) by the diets containing alfalfa compared to others (zinc and fasting) (Table 3). The birds fed diets with 90 and 70% alfalfa returned to posture after 14.11 days and 14.33 days, respectively. These data are consistent with those of Donalson et al. (2005) and Landers et al. (2005), who reported that birds fed the highest percentages of alfalfa returned posture in 14.8 days and 14 days, respectively.

The comparison between the diet containing zinc and fasting showed a significant effect ($p<0.05$) on the days needed for laying the 1st egg. The hens (control) that fasted during molting laid the 1st egg sooner than those fed the diet supplemented with zinc. Unlike Domingues et al. (2012) who reported that this parameter (laying the first egg) was not significantly affected by zinc added to the diet.

The number of days to lay the first egg decreased ($p<0.05$) linearly with increasing temperature. Therefore, the birds fed the diets in the warm temperature returned to posture sooner compared with birds kept at lower temperatures.

Egg production and egg mass were not affected by treatments ($p>0.05$). Egg weight and recovery of body weight showed significant interactions ($p<0.05$) between diets and the temperatures to which they were submitted (Table 3).

At warm temperature, there was a quadratic effect ($p<0.05$) between diets with inclusion of alfalfa (Table 4) in the ration. The birds kept at warm temperature and subjected to the induced molt with the inclusion of 50% alfalfa displayed the best (66.54 g) egg weight. Therefore, although the birds had lower weight loss during molting, loss higher than 25% was sufficient to cause an efficient ovarian regression (BAKER et al., 1983), which, in turn, affected positively egg weight during the rest.

For the 70% alfalfa diet, egg weight decreased ($p<0.05$) linearly with increasing temperature, with the best result (68.96 g) for birds kept in cold temperature, probably due to greater feed intake (Table 3).

The body weight recovery parameter displayed a negative linear effect ($p <0.05$) with inclusion of alfalfa in the diet for birds kept in cold temperature, with lower recoveries for birds fed 50% alfalfa. This result reflects the lower weight loss of the poultry during the molt.

At thermoneutral temperature, weight recovery was higher (32.41%) for fasting hens compared to those fed diets containing zinc oxide. At warm temperature, there was a quadratic effect ($p<0.05$) for diets with alfalfa inclusion while the highest percentages of bodyweight recovery were reached for the inclusion of 50 and 90% alfalfa.

Birds fed the 50% alfalfa diet showed a linear increasing trend ($p<0.05$) for the parameter bodyweight recovery and, therefore, had greater body recovery during rest compared to other treatments.

The other diets displayed quadratic effect ($p<0.05$) for the recovery of body weight in relation to temperature. The 70% alfalfa diet fed to poultry kept in cold thermoneutral temperatures provided a bodyweight recovery similar and higher compared to birds kept at warm temperature. The highest bodyweight recovery for birds fed zinc oxide and the fasting ones was observed at warm and thermoneutral temperatures, respectively.

Table 2 - Means for the performance parameters of the poultry during molting.

Treatments	Evaluated parameters [1]					
	FI (g/bird/day)	CEM (kcal/kg)	EP (%/bird/day)	BWL (%)	DCP (day)	PV (%)
			Diets (D)			
90% alfalfa	1.97 ± 0.90	33 ± 15	5.09 ± 2.00	29.26 ± 2.16	3.67 ± 2.12	97.48 ± 5.69
70% alfalfa	7.75 ± 2.52	173 ± 56	5.31 ± 4.11	26.30 ± 2.69	3.67 ± 3.08	98.15 ± 5.56
50% alfalfa	11.29 ± 2.79	316 ± 78	6.32 ± 3.08	25.08 ± 2.84	4.22 ± 2.68	90.74 ± 12.11
Zinc	4.62 ± 1.88	196 ± 80	6.57 ± 3.39	29.30 ± 2.67	3.89 ± 2.26	94.37 ± 9.42
Fasting	-	-	6.02 ± 3.84	30.26 ± 1.45	3.44 ± 1.94	100.00 ± 0.00
			Temperature (T)			
Cold temperature	6.40 ± 4.33	174 ± 115	5.45 ± 4.16	28.26 ± 3.64	3.47 ± 2.75	95.00 ± 8.80
Thermoneutral	8.07 ± 4.25	225 ± 120	5.40 ± 2.07	27.22 ± 2.95	2.73 ± 1.49	95, 56 ± 9.90
Warm temperature	5.66 ± 3.83	165 ± 122	6.73 ± 3.25	28.65 ± 2.50	5.13 ± 2.10	98.47 ± 4.50
			F values for variance analysis			
Diet	31.52 *	26.70 *	0.31 NS	7.61 *	0.17 NS	2.06 NS
Temperature	3.08 NS	2.01 NS	0.72 NS	1.40 NS	4.91 *	0.95 NS
Interaction D x T	1.15 NS	0.96 NS	0.85 NS	0.87 NS	1.53 NS	1.45 NS
CV (%)	30.09	33.00	58.68	8.64	56.91	7.69
			F values for the contrasts			
Alfalfa x others	-	-	-	15.55 *	-	-
Zinc x fasting	80.81 *	79.60 *	-	13.42 *	-	-
Alfalfa linear effect	1.89 NS	0.00 NS	-	0.76 NS	-	-
Alfalfa quadratic effect	-	-	-	0.71 NS	-	-
Temperature linear effect	-	-	-	-	4.51 *	-
Temperature quadratic effect	-	-	-	-	5.31 *	-

NS not significant, *P <0.05. [1]FI = feed intake, EP = egg production, BWL = body weight loss during molt, DCP = days to cease posture and PV = production viability. ± standard deviation.

Table 3 - Means for the performance parameters of birds during the rest period.

Treatments	Evaluated parameters [1]						
	FI (g/bird/day)	ERP (%/bird/ day)	EP (g)	FCR (kg/dz)	DRP (days)	DP1$^{st.}$ (days)	BWR (%)
Diets (D)							
90% alfalfa	91.32 ± 12.57	19.17 ± 7.81	63.47 ± 5.55	6.46 ± 2.20	14.11 ± 5.28	9.78 ± 2.64	27.24 ± 9.26
70% alfalfa	90.08 ± 19.52	19.26 ± 4.66	63.39 ± 7.65	5.88 ± 1.97	14.33 ± 4.36	10.22 ± 3.35	23.29 ± 7.35
50% alfalfa	97.48 ± 16.11	18.29 ± 7.11	65.53 ± 2.62	7.33 ± 3.00	11.44 ± 3.00	8.56 ± 2.60	26.31 ± 8.40
Zinc	86.44 ± 18.27	19.96 ± 10.39	65.81 ± 2.87	5.77 ± 3.40	17.11 ± 6.03	12.78 ± 3.11	23.94 ± 9.41
Fasting	91.64 ± 12.19	16.80 ± 3.90	65.09 ± 2.13	6.74 ± 1.17	16.56 ± 5.94	9.44 ± 2.60	27.14 ± 5.82
Temperature (T)							
Cold temperature	100.45 ± 16.69	18.10 ± 7.74	66.40 ± 2.27	7.51 ± 2.72	16.87 ± 4.31	11.40 ± 2.03	25.85 ± 4.11
Thermoneutral	95.15 ± 11.69	17.46 ± 6.01	66.06 ± 4.90	6.49 ± 1.85	16.80 ± 5.72	10.87 ± 3.68	23.10 ± 7.64
Warm temperature	78.57 ± 8.84	20.52 ± 7.94	61.52 ± 4.55	5.31 ± 2.29	10.47 ± 2.39	8.20 ± 2.48	27.85 ± 10.78
F values for variance analysis							
Diet	0.85 ^{NS}	0.27 ^{NS}	0.89 ^{NS}	0.69 ^{NS}	3.11 *	4.19 *	0.82 ^{NS}
Temperature	11.62 *	0.80 ^{NS}	8.33 *	3.37 *	13.80 *	8.13 *	1.48 ^{NS}
Interaction MD x T	0.96 ^{NS}	1.28 ^{NS}	2.31 *	1.10 ^{NS}	1.48 ^{NS}	1.85 ^{NS}	5.51 *
CV (%)	14.19	37.44	5.66	36.11	26.05	22.93	22.29
F values for the contrasts							
Alfalfa x others	-	-	-	-	9.20 *	5.05 *	-
Zinc x fasting	-	-	-	-	2.18 ^{NS}	1.24 ^{NS}	-
Alfalfa linear effect	-	-	-	-	0.99 ^{NS}	1.23 ^{NS}	-
Alfalfa quadratic effect	-	-	-	-	0.09 ^{NS}	9.22 *	-
Temperature linear effect	21.35 *	-	-	6.73 *	20.91 *	14.16 *	-
Temperature quadratic effect	1.89 ^{NS}	-	-	0.01 ^{NS}	6.68 ^{NS}	2.10 ^{NS}	-

^{NS} - not significant, *$P < 0.05$. [1]FI = feed intake, ERP = eggs relative production, EW = egg weight, FCR = feed conversion rate, DRP = days to return to posture, DP1st = days for posture of 1st egg and BWR = body weight recovery . ± standard deviation.

Table 4 - Means for the performance parameters that have significant interaction during the rest period.

Egg weight (g)	Temperatures			Linear effect	Quadratic effect
Diets	Cool	Thermoneutral	Warm	temperature	temperature
90% alfalfa	65.28 ± 3.60	66.75 ± 6.29	58.40 ± 11.69	3.35 NS	2.27 NS
70% alfalfa	68.96 ± 1.68	65.28 ± 4.56	55.94 ± 0.67	7.70 *	0.48 NS
50% alfalfa	66.75 ± 0.87	63.30 ± 3.44	66.54 ± 4.38	0.01 NS	4.12 NS
Zinc	66.58 ± 3.44	67.93 ± 1.60	62.92 ± 11.69	4.72 NS	7.74 NS
Fasting	64.42 ± 2.26	67.07 ± 6.24	63.78 ± 1.70	0.20 NS	5.90 NS
Alfalfa x others	2.23 NS	0.70 NS	4.84 NS		
Zinc x fasting	0.90 NS	0.60 NS	14.30 *		
Alfalfa linear effect	4.81 NS	0.00 NS	12.25 *		
Alfalfa quadratic effect	1.95 NS	0.04 NS	0.16 NS		
Recovery of body weight (%)	Temperatures			Linear effect	Quadratic effect
Diets	Cool	Thermoneutral	Warm	temperature	temperature
90% alfalfa	29.94 ± 0.00	17.39 ± 7.98	31.12 ± 0.36	0.03 NS	3.82 NS
70% alfalfa	27.09 ± 2.44	26.90 ± 8.66	12.15 ± 4.27	28.00 *	10.24 *
50% alfalfa	18.85 ± 0.75	21.93 ± 0.39	35.66 ± 3.95	26.94 *	4.16 NS
Zinc	25.75 ± 1.92	14.96 ± 2.87	31.12 ± 0.93	0.86 NS	7.21 *
Fasting	25.28 ± 2.81	32.41 ± 1.04	22.03 ± 0.00	0.70 NS	7.77 *
Alfalfa x others	0.02 NS	0.42 NS	0.00 NS		
Zinc x fasting	20.00 *	1.19 NS	0.42 NS		
Alfalfa linear effect	1.82 NS	4.63 NS	9.19 *		
Alfalfa quadratic effect	0.04 NS	21.8 *	1.35 NS		

NS - not significant, * P <0.05. ± standard deviation.

CONCLUSION

The results presented indicate that alfalfa can be used to induce molt in laying hens, allowing to obtain sufficient weight loss during molt and to return to posture sooner. Thus, diets with alfalfa can be used as an alternative to the fasting method, regardless of the temperature at which it is performed.

REFERENCES

ALODAN, M. A.; MASHALY, M. M. Effect of induced molting in laying hens on production and immune parameters. **Poultry Science,** v.78, p.171-177, 1999.

ANDREWS, D. K.; BERRY, W. D.; BRAKE, J. Effect of lighting program and nutrition on reproductive performance of molted single comb white leghorn hens. **Poultry Science,** v.66, p.1298–1305, 1987b.

BAKER, M.; BRAKE, J.; McDANIEL, G. R. The relationship between body weight loss during an induced molt and postmolt egg production, egg weight, and shell quality in caged layers. **Poultry Science**, v.62, p.409–413, 1983.

BRAKE, J. Recents advances in induced molting. **Poultry Science,** v.72, p.929-931, 1993.

BRINK, M. F.; BECKER, D. E.; TERRILL, S. W.; JENSEN, A. H. Zinc toxicity in the weaning pig. **Journal Animal Science,** v.18, p.836-842, 1950.

DOMINGUES, C. H. F.; SGAVIOLI S.; PRAES M. F. F. M.; ALVA, J. C. R.; CASTIBLANCO, D. C.; GRAVENA, R. A.; MARQUES, R. H.; JUNQUEIRA, O. M. Métodos de muda induzida sobre o desempenho pós muda de poedeiras comerciais. In: X CONGRESSO APA DE PRODUÇÃO E COMERCIALIZAÇÃO DE OVOS, 2012, Ribeirão Preto. **Anais...** Ribeirão Preto: APA, 2012.

DONALSON, L. M.; KIM, W. K.; HERRERA, P.; KUBENA, L.F.; NISBET, D.J.; RICKE, S.C.. Utilizing different ratios of alfalfa and layer ration for molt induction and performance in commercial laying hens. **Poultry Science**, v.84, p.362–369, 2005.

FOX, M. R. S. Zinc excess. In: MILLS, C. F. (Ed) **Zinc in Human Biology**. ed. Spring-Verlag:New York, 1989. p.365-370.

FURLAN, R. L.; MACARI, M. Termorregulação. In: MACARI, M.; FURLAN, R. L.; GONZALES, E. **Fisiologia aviária aplicada a frangos de corte.** 2. ed. Jaboticabal: Funep, 2002. p.209-230.

GIRARDON, J. C. **Métodos nutricionais de muda forçada em poedeiras semi-pesadas.** Pelotas: Universidade Federal de Pelotas, 2011. 81p. Dissertação (Mestrado em Zootecnia) – Faculdade de Agronomia Eliseu Maciel, 2011.

HURWITZ, S.; WEISELBERG, M.; EISNER, U. et al. The energy requirements and performance of growing chickens and turkeys as affected by environmental temperature. **Poultry Science,** v.59, p.2290–2299, 1980.

JOHNSON, A. L.; BRAKE, J. Zinc-induced molt: Evidence for a direct inhibitory effect in granulose cell steroidogenesis. **Poultry Science,** v.71, p.161–167, 1992.

KWON, Y. M.; KUBENA, L. F.; WOODWARD, C. L.; BYRD, J. A.; MOORE, R. W.; NISBET D. J.; RICKE, S. C. Use of an alfalfa diet for molting in leghorn hens to reduce *Salmonella enteritidis* colonization and invasion. **Poultry Science,** 80(Suppl.1):90. (Abstr.). 2001.

LANDERS, K. L.; WOODWARD, C. L.; LI, X.; KUBENA, L. F.; NISBET, D. J.; RICKE, S. C. Alfalfa as a single dietary source for molt induction in laying hens. **Bioresource Technology,** v.96, p.565-570, 2005.

MATSUSHIMA, J. K. Feedlot Feeding. In: HANSON, C. H. (Ed) **Alfalfa Science and Technology**. ed. American Society of Agronomy:Madison, WI. 1972. p.632–640.

MROSOVSKY, N.; SHERRY, D. F. Animal anorexias. **Science,** v. 207, p.837–842, 1980.

NORTH, M. O.; BELL, D. D. **Commercial chicken production manual.** 4.ed. New York: Chapman and Hall, 1990. 452p.

PARK, S. Y.; BIEKHOLD, S. G.; KUBENA, L. F.; NISBET, D. J.; RICKE, S. C. Effects of high zinc diets using zinc propionate on molt induction, organs and postmolt egg production and quality in laying hens. **Poultry Science,** v.83, p.24–33, 2004.

ROLAND, D. A.; BRAKE, J. H. Influence of premolt production on postmolt performance with explanation for improvement in egg production due to force molting. **Poultry Science,** v.61, n.12, p.2473-2481, 1982.

ROSTAGNO, H. S.; ALBINO, L. F. T.; DONZELE, J. L.; GOMES, P. C.; OLIVEIRA, R. F. de; LOPES, D. C.; FERREIRA, A. S.; BARRETO, S. L. de T. **Tabelas brasileiras para aves e suínos: composição de alimentos e exigências nutricionais.** 3.ed. Viçosa: UFV, 2005.

SAS. INSTITUTE. **SAS ® user' guide: statistics.** Cary, NC, 2002.

SEN, S.; MAKKAR, H. P. S.; BECKER, K. Alfalfa saponins and their implications in animal nutrition.

Journal of Agriculture and Food Chemistry, v.46, p.131–140, 1988.

SIBBALD, I. R. Passage of feed through the adult rooster. **Poultry Science,** v.58, p.446-459, 1979.

TINÔCO, I. F. F. Estresse calórico – meios naturais de condicionamento. In: SIMPÓSIO INTERNACIONAL SOBRE AMBIENCIA E INSTALAÇÃO NA AVICULTURA INDUTRIAL, 1995, Curitiba. **Anais...** Campinas: Facta, 1995.

UEDA, H.; TAKAGI, A.; KATOU, K.; MATSUMOTO, S. Feeding behavior in chicks fed tea saponin and quinine sulfate. **Journal of Poultry Science,** v.39, p.34–41, 2002.