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Methods of feed restriction for molt induction in commercial laying hens

Métodos de restrição alimentar para induzir a muda em poedeiras comerciais

Josenio Cerbaro[1]; Amanda D'avila Verardi[1*]; Vladimir de Oliveira[2]; Clóvis Eliseu Gewehr[3]

Abstract

An experiment was carried out to evaluate methods of quantitative or qualitative feed restriction for inducing molt on the performance of Hy - Line Brown layers in the second lay cycle. Two hundred and twenty - five birds with 88 wks-old Hy - Line Brown were used in a completely randomized design with five treatments: $Quant_{100}$ – restriction of 100% of the daily amount recommended by lineage manual; $Quant_{75}$ – restriction of 75% of the daily amount recommended; $Quant_{50}$ – restriction of 50% of the daily amount recommended; $Qual_{75}$ – supply of an *ad libitum* diet with 75% grinded rice hulls and 25% of basal diet; $Qual_{50}$ – supply of an *ad libitum* diet with 50% of grinded rice hulls and 50% of basal diet. The feed conversion ratio per dozen eggs and egg mass was similar (P=0.0035 and P=0.0139) between $Quant_{75}$ and $Qual_{75}$ methods, in relation to $Quant_{100}$. The eggs production was similar (P=0.0122) among the hens from $Quant_{75}$, $Quant_{50}$ and $Qual_{75}$ methods, in relation to $Quant_{100}$. The methods of feed restriction did not alter the eggs density (P=0.8971). $Quant_{75}$ or $Qual_{75}$ methods can substitute the conventional method for inducing molt in Hy-Line Brown layers, without modifying the performance in the second lay cycle.
Key words: Brow egg, commercial laying, *Gallus gallus,* molt, performance

Resumo

O objetivo do trabalho foi avaliar métodos de restrição alimentar quantitativa ou qualitativa para a indução a muda sobre o desempenho de poedeiras Hy-Line Brown no segundo ciclo de produção. Foram utilizadas 225 aves com 88 semanas de idade em um delineamento inteiramente casualizado com cinco tratamentos: $Quant_{100}$ – restrição de 100% da quantidade diária de ração recomendada para a linhagem; $Quant_{75}$ – restrição de 75% da quantidade diária de ração recomendada; $Quant_{50}$ – restrição de 50% da quantidade diária de ração recomendada; $Qual_{75}$ – dieta com 75% de casca de arroz e 25% de dieta basal; $Qual_{50}$ – dieta com 50% casca de arroz e 50% de dieta basal. A conversão alimentar por dúzia e por massa de ovos foi similar (P=0,0035 e P=0,0139) para os métodos $Quant_{75}$ e $Qual_{75}$ em relação ao $Quant_{100}$. A produção de ovos foi semelhante (P=0,0122) para as poedeiras dos tratamentos $Quant_{75}$, $Quant_{50}$ e $Qual_{75}$ em relação ao $Quant_{100}$. Os métodos de restrição alimentar não alteraram (P=0,8971) a densidade dos ovos no segundo ciclo. Os métodos $Quant_{75}$ ou $Qual_{75}$ podem substituir o método tradicional ($Quant_{100}$) para induzir a muda em poedeiras Hy-Line Brown, sem alterações no desempenho das aves no segundo ciclo de produção.
Palavras-chave: Desempenho, *Gallus gallus*, ovo marrom, postura comercial, troca de penas

[1] Discentes, Universidade do Estado de Santa Catarina, UDESC, Centro de Ciências Agroveterinárias, Lages, SC, Brasil. E-mail: josenio.cerbaro@ig.com.br, amanda.davila@ifc-concordia.edu.br

[2] Prof., Universidade Federal de Santa Maria, UFSM, Deptº de Zootecnia, Santa Maria, RS, Brasil. E-mail: vladimir.oliveira@ufsm.com.br

[3] Prof., UDESC, Centro de Ciências Agroveterinárias, Lages, SC, Brasil. E-mail: a2ceg@cav.udesc.br

[*] Author for correspondence

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Introduction

Molting season in avian species may be defined as a period in which the bird performs molt. In a natural process, this exchange is slow in the hen, and involves impairment in its metabolism with weight loss and reduction in egg production. In modern commercial layers, the selective breeding for a high rate of egg production reduced or eliminated the endogenous biological cues that coordinate the initiation of seasonal molting. It remained the ability to tolerate prolonged fasting and undergo a spontaneous regression of the reproductive tract (BERRY, 2003).

Molting induction can be utilized in commercial layers for providing the regression and recovering of the reproductive tract. This allows optimizing eggs production and shell quality, which naturally lose thickness and strength with the advancing hen age (GIAMPAULI; PEDROSO; MORAES, 1995). Besides, forced molting permits to postpone the replacement of layers flock from around 25 to 30 weeks (RAMOS et al., 1999). It represents an advantage in terms of economic issues, because it is possible to avoid the expenses with the purchase and rearing of birds until the onset of hens' production, which occur in around 20 weeks.

One of the effective methods on inducing molt in layers is a total feed and/or water deprivation with a decrease in the photoperiod from 4 to 14 days. Fasting showed to be effective (RAMOS et al., 1999; BAR et al., 2003; HASSANIEN, 2011), it is easy to apply and has low cost. However, total feed restriction and/or water deprivation have been contested for impairing the layers' welfare. There is an increasing concern in researching alternative methods that avoid fast and provide similar results to the traditional method.

The aim of the present study was to evaluate different methods of quantitative and qualitative feed restriction for inducing molt on performance and eggs quality of commercial layers in a second-lay cycle.

Materials and Methods

The experiment was carried out at the experimental aviary in the Center of Agroveterinary Sciences of the Universidade do Estado de Santa Catarina (UDESC, Lages, Santa Catarina, Brazil). The total experimental period was of 147 days and divided in three phases (molting, recovery and post-molting production), extending from 12/02/11 to 04/27/12. Two hundred and twenty- five birds of 88wks-old Hy-Line Brown were housed in cages (0.25 m long x 0.45 m deep x 0.40 m high), in an aviary open equipped with trough feeder, nipple drinking system and frontal egg collector. At housing, the birds were submitted to a natural decreasing photoperiod of 13 hours and 54 min. At this moment and during the next four days, the birds received water and *ad libitum* feeding in order to get adapted to the new environment.

For molting induction, five feed restriction methods were evaluated, being three of them of quantitative restriction (Quant) and two of qualitative restriction (Qual): $Quant_{100}$ (control) – restriction of 100% of the daily amount recommended by lineage manual (115 grams/hen/day); $Quant_{75}$ – restriction of 75% of the daily amount recommended by lineage manual or 28.7 g/hen/day; $Quant_{50}$ – restriction of 50% of the daily amount recommended by lineage manual or 57.5 g/hen/day; $Qual_{75}$– supply of an *ad libitum* diet with 75% grinded rice hulls and 25% basal diet; $Qual_{50}$– supply of an *ad libitum* diet with 50% grinded rice hulls and 50% basal diet. The basal diet was based on corn and soybean meal, and the nutritional requirements values used as well as feed composition were recommended by Rostagno et al. (2005) for semi-heavy laying hens (Table 1).

The experimental design was completely randomized, constituted of five treatments, nine replications and five birds by experimental unit.

At the onset of molting period, the birds were weighed, and this procedure was repeated every five days after the beginning of the restriction methods application. In this sense, the body weight was used as a reference of the time in which feed restriction should be interrupted, considering the criteria of 25% body weight reduction in relation to the initial body weight as recommended by Hussein (1996) or a period of 21 days on restriction.

Table 1. Composition of basal diet (1) (2)(3).

Ingredients	Composition, %
Corn	59.20
Soybean meal	27.50
Limestone	9.65
Dicalcium phophate	1.30
Soybean oil	1.40
DL-Methionine	0.15
Vitaminic-mineral mixture[2]	0.30
Salt	0.30
Adsorvent	0.20
Calculated levels	
Metabolizable energy, kcal kg^{-1}	2,745
Crude protein, g/hen/day	17.0
Calcium, g/hen/day	4.2
Available phosphorus, g/hen/day	0.375
Digestible methionine, g/hen/day	0.408

(1) As fed basis. (2) Composition per kilogram of mixture: Vit. A - 2.333.330 UI, Vit. D3 - 666.670 UI, Vit. E - 1.666.670, Vit. K3 - 533.330, Vit. B2 - 1.000 mg, Vit. B12 - 2.666.670 mcg, Niacine- 6.666.670 mg, Choline- 78.120 mg, Phanthothenic acid- 1.166.670 mg, Cupper- 2.666.700 mg, Iron-16.670 g, Manganese-23.330 g, Zinc-16.670 g, Iodine- 400 mg, Selenium - 66.670 mg, Zinc bacitracin - 6.666.670 mg. (3) Corn 8.26% crude protein (CP); Soybean 45% CP.
Source: Elaboration of the authors.

After interrupting the restriction methods and molting process, there was a recovery period of 21 days in which daily feed amount (corn-soybean meal diet) provided to the birds was increased gradually. This period is necessary for birds regaining feathers and recovering part of the weight lost in the molting phase (WEBSTER, 2003). At the recovery period and until the end of the experiment, a 16-hour photoperiod was used. The photoperiod was gradually increased from 14-hour to 16-hour using an addition of 30 min of artificial light per week.

The production phase began after the recovering period. It was possible to assess in five periods of 21 days, feed intake (g/hen/day), weight gain (g), eggs production (%/hen/day), feed conversion ratio (grams/grams, grams/dozen eggs, grams/egg mass), livability (%), egg weight (g) and their densities (g/cm^3).

Data collected in molting induction phase, post-restriction and recovery post-molting were analyzed by descriptive statistics and graphical analysis in order to look at biological consistency data. Initial body weight, post-restriction weight and weight after the recovery period were analyzed by using a generalized linear model, and Tukey test ($p<0.05$) was applied for means comparison among the methods.

Data collected in each period, in the production phase (post-molting), were submitted to repeated measures analysis of variance (*mixed* procedure) considering the molting induction method, period and the interaction method versus period as fixed effects. When the method effect was significant to the analyzed variables, Tukey test ($p<0.05$) was used for means comparison (SAXTON, 1998). To the variables that presented significant effect in the interaction between method and period, a means comparison was realized by using orthogonal contrasts for those periods in which significant differences were detected, after the sliced interaction. The used contrasts were: C_1 – traditional method of molting induction versus alternative methods; C_2 – quantitative methods versus qualitative methods of feed restriction. All of the analyses were performed with the software SAS version 9.1.3 (SAS, 2003).

Results and Discussion

Bird's weights at the beginning of the experiment and recovering phase were not different among the methods, and also after the feed restriction period differed as it was expected (Table 2).

Table 2. Initial body weight (g), post restriction weight, weight reduction (%), days to interrupt the lay and weight after the recovering period (88 - 91 wks) of layer hens submitted to different methods for inducing molt [(1)].

Method	Variables				
	Initial	Post restriction	Reduction, %	Days to interrupt lay[(2)]	Recovering
$Quant_{100}$	1911	1405^{d}	26.5^{a}	4	2002
$Quant_{75}$	1910	1522^{c}	20.4^{b}	8	2070
$Quant_{50}$	1913	1652^{b}	13.5^{c}	NI	2023
$Qual_{75}$	1903	1466^{cd}	23.0^{ab}	5	1935
$Qual_{50}$	1921	1769^{a}	7.9^{d}	NI	1935
Probability	0.893	0.000	0.000	-	0.133
CV, %	2.2	10.2	-	-	6.8

[(1)] Means within columns, with no common superscripts, differ significantly according to Tukey test (P<0.05). [(2)] NI - Not interrupted the lay.
Source: Elaboration of the authors.

The results of layers' feed intake are presented in table 3. In the 4th and 5th periods of evaluation, the birds on conventional feed restriction method ($Quant_{100}$) consumed, respectively, 3.9 (P=0.0004) and 3.2% (P=0.0037) more feed than the laying hens fed through the alternative methods of feed restriction (C_1). In the 4th experimental period, the feed consumption of hens on quantitative restriction was about 3.0% higher (P=0.0008) than those birds on qualitative restriction (C_2) to induce molting.

Table 3. Feed intake (grams day^{-1}) of layers (94 - 109 wks) submitted to different methods for inducing molt.

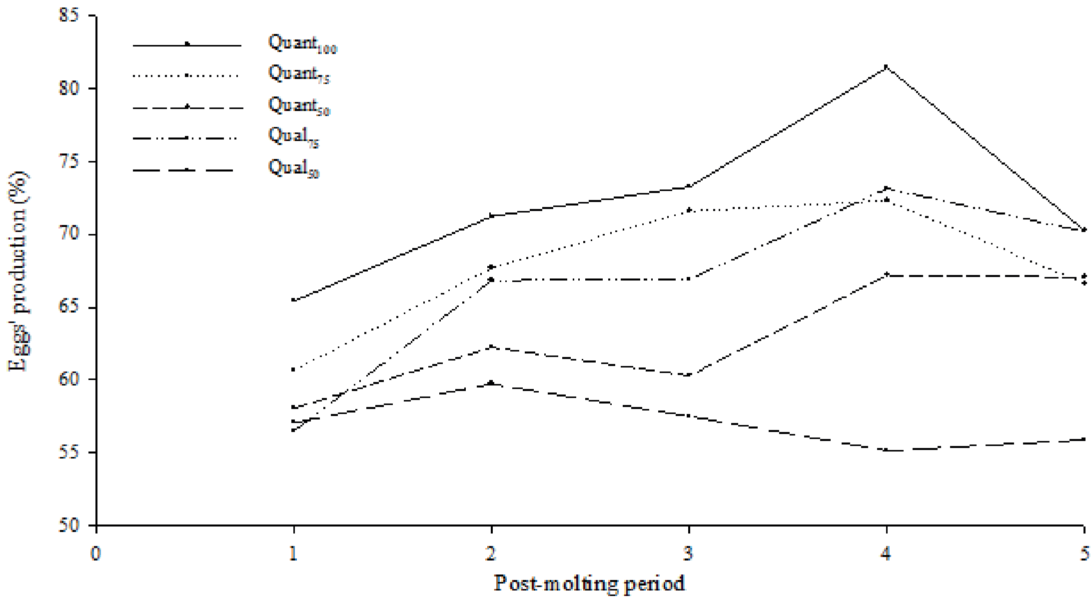
Method	Periods					
	1	2	3	4	5	Mean
$Quant_{100}$	103.2	103.7	105.9	112.7	110.7	107.3
$Quant_{75}$	103.6	104.5	107.8	110.7	107.8	106.9
$Quant_{50}$	103.3	103.1	104.2	108.3	107.0	105.2
$Qual_{75}$	102.5	104.9	106.8	109.4	107.3	106.2
$Qual_{50}$	102.3	103.6	104.9	105.0	106.6	104.5
C.V[(1)], %	2.9	3.1	3.1	4.5	3.4	3.9
Contrasts						
C_1 (Traditional method *vs* alternatives)				0.0004	0.0037	
C_2 (Quantitative methods *vs* qualitatives)				0.0008	0.1080	
Effects						
Method, M	0.0255					
Period, P	<.0001					
M x P	0.0361					

[(1)] Coefficient of variation.
Source: Elaboration of the authors.

The feed intake of laying hens, in the post molting period, differs from results related in the literature on similar experiments (KESHAVARZ; QUIMBY, 2002; BIGGS et al., 2003; SOUZA et al., 2010). In these papers, the utilization of quantitative or qualitative feed restriction for inducing molt did not influence birds' feed intake on the second-lay cycle. Perhaps, in this experiment, the rate of eggs production was the regulating factor of birds' feed intake (HY-LINE, 2010).

For most of treatments (with the exception of $Qual_{50}$), the eggs production peak on the second-laying cycle was observed at the onset of the 4th period, and the birds on the conventional feed restriction method produced more eggs, in the 4th and 5th experimental period (Figure 1). Moreover, the difference in feed intake of the birds on the traditional method, in relation to the alternative methods (C_1), could be related to the use of rice hulls in the diets. The highest fiber content on $Qual_{75}$ and $Qual_{50}$ rations probably reduced the rate of feed passage and its digestibility.

Figure 1. Egg's production of layers (94 – 100 wks) after feed restriction for inducing molt.



Source: Elaboration of the authors.

The results of this work suggest that the feed restriction method for inducing molt was a determinant of feed intake when there were larger nutritional and physiological demands (lay peak) by the bird, in its second cycle. In the proximity of lay peak, a mobilization of body reserves can occur for supporting the energetic demand of eggs production (LEESON; SUMMERS, 2009). Even if the feed supply in the second-lay cycle were *ad libitum*, it could occur a mobilization of body reserves for supporting part of the energetic demand of eggs production. Thus, this mobilization might not have been enough and the birds on $Quant_{100}$ method consumed more feed as a compensatory mechanism of the energetic metabolism.

The results of live body weight, feed conversion ratio and livability of laying hens are presented in tables 4 and 5. The methods of feed restriction did not interfere on the live body weight, feed conversion ratio (g g^{-1}) nor birds livability. However, the treatments influenced the feed conversion ratio in grams per dozen eggs (FCR g/dozen) and egg mass (FCR g/mass). The birds that received total feed restriction for inducing molt had better feed conversion per dozen eggs (P=0.0035) and egg mass (P=0.0139) than those submitted to a restriction of 50% on daily feed amount ($Quant_{50}$) or received a diet with rice hulls ($Qual_{50}$). On the other hand, $Quant_{75}$ and $Qual_{75}$ feed restriction methods had similar results of feed conversion per dozen eggs and egg mass in relation to the conventional method of feed restriction ($Quant_{100}$).

Table 4. Live weight [(1)] (kg) of layers (94 - 109 wks) submitted to different methods for inducing molt.

Method	Periods					
	1	2	3	4	5	Mean
$Quant_{100}$	1.88	1.79	1.85	2.00	2.02	1.90
$Quant_{75}$	1.87	1.86	1.91	2.00	2.02	1.93
$Quant_{50}$	1.91	1.85	1.90	1.98	1.97	1.91
$Qual_{75}$	1.86	1.82	1.86	1.94	1.92	1.88
$Qual_{50}$	1.91	1.84	1.84	1.93	1.95	1.89
C.V[(1)], %	3.6	4.7	5.2	4.6	4.8	5.5
Effects						
Method, M	0.5641					
Period, P	<.0001					
M x P	0.0788					

[(1)] Coefficient of variation.
Source: Elaboration of the authors.

Table 5. Feed conversion [(1)] and livability (%) of layers (94 - 109 wks) submitted to different methods for inducing molt.

Method	Variables[(2)]			
	F.C, $g\ g^{-1}$	F.C, $g\ dz^{-1}$	F.C, $g\ mass^{-1}$	Livability, %
$Quant_{100}$	1.62	1.76[b]	2.18[b]	99.5
$Quant_{75}$	1.60	1.96[ab]	2.31[ab]	99.1
$Quant_{50}$	1.59	2.05[a]	2.49[a]	98.6
$Qual_{75}$	1.61	1.96[ab]	2.40[ab]	98.3
$Qual_{50}$	1.56	2.14[a]	2.47[a]	98.0
C.V[(3)], %	5.9	15.9	14.6	5.2
Method, M	0.1880	0.0035	0.0139	0.5693
Period, P	0.2237	0.0056	0.0255	0.7348
M x P	0.6424	0.5005	0.2968	0.1030

[(1)] F C R – feed conversion ratio (g/g; g/dozen eggs and g/eggs mass);
[(2)] Means within columns, with no common superscripts, differ significantly according to Tukey test (P<0.05);
[(3)] Coefficient of variation.
Source: Elaboration of the authors.

Quantitative or qualitative feed restriction was associated to the increase of feed efficiency in birds (URDANETA-RINCON; LEESON, 2002; FASSBINDER-ORTH; KARASOV, 2006). This improvement is linked to a better digestive capacity resulting from an increase in the digestive organs masses involved in feed digestion. In experiments with broilers submitted to feed restriction and after re-feed *ad libitum,* larger masses of intestine, liver and pancreas were observed. In addition, there was an increase in maltase activity in the duodenum. In these birds, the better feed efficiency would be a result of higher capacity of enzymatic degradation and nutrients absorption (FASSBINDER-ORTH; KARASOV, 2006). In this study, birds on a severe feed restriction ($Quant_{100}$) for inducing molt were more efficient in feed conversion per dozen eggs and egg mass, in the second-lay cycle. The re-feeding of these birds in this period combined to a larger reduction in body weight (26.5%) could favor the digestion and absorption of nutrients from the diet. The feed conversion per dozen eggs and egg mass of birds on $Qual_{75}$ and $Quant_{75}$ methods did not differ from birds on $Quant_{100}$ method. Possibly, the increase of digestive capacity is related to the intensity of body weight reduction after restriction. Considering the weight reductions of layers in this experiment, $Quant_{100,}$ $Qual_{75}$ and $Quant_{75}$ methods were the ones that caused larger losses (26.5, 23.0 and 20.4%) on inducing molt. This effect, associated with re-feeding in the second-lay cycle, contributed to increase the birds' digestive capacity and feed efficiency.

In tables 6, 7 and 8 it is presented the production of eggs, eggs mass and eggs 'density of layer hens, respectively. The eggs' production was approximately 21% higher (P=0.0122) for birds on the conventional method of restriction ($Quant_{100}$) in relation to those that received a diet with 50% of rice hulls ($Qual_{50}$). In relation to the method $Quant_{100}$, however, the eggs' production was similar among the layer hens from methods $Quant_{75}$, $Quant_{50}$ and $Qual_{75}$. The eggs' masses of birds on methods $Quant_{50}$ and $Qual_{50}$ were 13 and 15% smaller in relation to the eggs' mass of layers on the traditional method, respectively. The methods of feed restriction did not alter the eggs' density (P=0.8971).

The results of eggs' production in the post-molting phase are in agreement with previous studies (RAMOS et al., 1999; KESHAVARZ; QUIMBY, 2002; MOLINO et al., 2009). In these publications, the number of eggs was greater for birds that received total feed restriction for inducing molt.

Table 6. Production (% day^{-1}) of eggs from layers (94 - 109 wks) submitted to different methods for inducing molt.

Method	Production, % day^{-1} [(1)]
$Quant_{100}$	72.33[a]
$Quant_{75}$	67.78[ab]
$Quant_{50}$	62.97[ab]
$Qual_{75}$	66.72[ab]
$Qual_{50}$	57.06[b]
C.V[(2)], %	20.0
Method, M	0.0122
Period, P	<.0001
M x P	0.1592

[(1)] Means within columns, with no common superscripts, differ significantly according to Tukey test (P<0.05);
[(2)] Coefficient of variation.
Source: Elaboration of the authors.

In the inducing molt phase, an ovary regression occurs by the decrease of gonadotropins. The magnitude of this regression depends on the body weight reduction in hens. Such losses, of around 25%, cause complete ovarian involution (BERRY, 2003). This involution and posterior renewal of the reproductive tract in post molting period are essential for a good performance of the bird, in terms of production and eggs' shell quality (WEBSTER, 2003). Besides, the method of restriction utilized for inducing molt must cease the lay entirely, so this interfere positively on eggs' production in the second cycle (MAZZUCO, 2010). In this experiment, the birds on the method $Qual_{50}$ lose only 7.9% of body weight without ceasing lay. This explains the lower eggs' production in relation to the birds on method $Quant_{100}$ (57.06% *vs* 72.33%). The method $Qual_{50}$ consisted of a diet with the inclusion of 50% of rice hulls; therefore, it was fibrous and with low nutritional value. This diet, however, permitted a consumption reduction by limiting the ingestive capacity of the bird and reduction of the digesta passage by gut repletion (KOCH et al., 2005). Thus, $Qual_{50}$ method caused weight reduction in the layer, but not enough to induce a complete ovarian regression. On the other hand, $Quant_{75}$ and $Qual_{75}$ methods provided considerable reductions (20.4 and 23.0%) in hens' weight and cessation of laying. It is likely that, in those methods, the hypothalamic-pituitary-gonadal axis was inhibited with the regression of the reproductive tract, which resulted in eggs' production similar to the hens submitted to starving ($Quant_{100}$) for inducing molt. The data that we obtained in our experiment had high variation (CV around 20%), which could explain the lack of significative difference among treatments. The hens utilized in our research were older than ones used in most trials on molting subject.

Table 7. Mass (g) of eggs from layers (94 - 109 wks) submitted to different methods for inducing molt.

Method	Periods					
	1	2	3	4	5	Mean[1]
$Quant_{100}$	43.0	45.7	46.0	55.3	50.5	48.4[a]
$Quant_{75}$	41.5	45.1	46.6	49.4	43.6	45.6[ab]
$Quant_{50}$	38.5	40.7	40.0	45.3	45.0	41.9[b]
$Qual_{75}$	38.3	43.2	44.5	48.7	47.5	44.4[ab]
$Qual_{50}$	37.8	41.9	42.6	41.7	40.6	40.9[b]
C.V[2], %	16.3	13.9	15.5	17.8	18.6	17.4
Effects						
Method, M	0.0110					
Period, P	<.0001					
M x P	0.4564					

[1] Means within columns, with no common superscripts, differ significantly according to Tukey test ($P<0.05$);
[2] Coefficient of variation.
Source: Elaboration of the authors.

Table 8. Density (g cm^{-3}) of eggs from layers (94 - 109 wks) submitted to different methods for inducing molt.

Method	Periods					
	1	2	3	4	5	Mean
$Quant_{100}$	1077	1077	1079	1080	1078	1078
$Quant_{75}$	1079	1076	1081	1079	1079	1079
$Quant_{50}$	1079	1077	1079	1078	1077	1078
$Qual_{75}$	1077	1078	1080	1079	1075	1078
$Qual_{50}$	1076	1079	1079	1084	1078	1079
C.V[1], %	0.6	0.5	0.4	0.5	0.4	0.5
Effects						
Method, M	0.8971					
Period, P	<.0001					
M x P	0.3821					

[1] Coefficient of variation.
Source: Elaboration of the authors.

The hens on method $Quant_{50}$ lose a little weight (13.5%) and did not interrupt the lay, but eggs' production was similar to the hens on $Quant_{75}$, $Qual_{75}$ and $Quant_{100}$ methods. Possibly, the intensity of restriction applied (-50%) caused a partial regression of reproductive tract in the birds, with slight increase of small follicles, those ones responsible by the maintenance of follicular hierarchy and ovulation (OGUIKE; IGBOELI; IBE, 2006).

The eggs' mass is a function of weight, and also, a number of eggs produced so that it exists a positive and high correlation between feed intake and eggs' weight (LEESON; SUMMERS, 2009). In this experiment, the birds on methods $Quant_{50}$ and $Qual_{50}$ consumed, on average, less feed in the post-molting period than the hens on method $Quant_{100}$. Although it is not significant, a difference in intake of those birds was enough to alter the eggs' weight and their respective masses.

The egg shell quality decreases with the laying hen age. The forced molting is a practice of management that can improve the eggs shell quality in relation to the one in the end of the first cycle. This improvement occurs by cellular remodeling of shell gland (BERRY, 2003). During molt, cells are lost in the process of oviduct regression, and they are posteriorly recovered (HERYANTO; YOSHIMURA; TAMURA, 1997). In the present study, molt induction with the use of non conventional methods of restriction did not alter the eggs shell density. In our experiment some methods ($Quant_{50}$, $Qual_{50}$) for inducing molt did not provide a substantial weight reduction in the hens and thus a complete regression of the oviduct, which is important to note. This suggests, by considering density that the methods of feed restriction utilized in this experiment may be used for inducing molt in Hy-Line Brown layers, without changes in the eggs shell quality.

The results of eggs' layers weight are presented in table 9. As the contrast analysis (C_1), the eggs' hens weight on the conventional method of restriction was not different (P=0.6823) from the eggs' hens weight of birds fed by the alternative methods of restriction. In the same way, the eggs from birds fed on quantitative restriction had similar weights (P=0.1068) than the birds on qualitative restriction for inducing molt (C_2).

Table 9. Eggs weight (g) of layers (94 - 109 wks) submitted to different methods for inducing molt.

Method	Periods					
	1	2	3	4	5	Mean
$Quant_{100}$	65.5	64.7	65.3	67.7	67.6	66.2
$Quant_{75}$	67.8	66.5	65.9	68.0	66.4	66.9
$Quant_{50}$	64.5	65.3	65.4	67.4	66.9	65.9
$Qual_{75}$	65.1	64.5	60.8	67.2	67.2	64.9
$Qual_{50}$	66.1	66.6	67.3	67.3	67.3	66.9
C.V[(1)], %	4.3	4.8	5.1	4.5	4.9	4.9
Contrasts						
C_1 (Traditional method *vs* alternatives)			0.6823			
C_2 (Quantitative methods *vs* qualitatives)			0.1068			
Effects						
Method, M			0.2897			
Period, P			<.0001			
M x P			0.0081			

[(1)] Coefficient of variation.
Source: Elaboration of the authors.

The results of eggs' weight presented a significant interaction between the method of inducing molt and the period evaluated (P=0.0081). The statistical model indicated a significant difference among methods of feed restriction in the 3rd period, after slicing the interaction. It was not observed, by using contrasts of interest (C_1 and C_2), any significant effect on the eggs' hens weight from the traditional method of restriction in relation to others (P=0.6823), nor quantitative methods versus qualitative methods (P=0.1068). It is possible to say that the method effect on eggs' weight was a result of differences in the feed consumption among birds. These differences might be initiated at the 3rd period, and they become prominent from 4th period, which is the moment of laying peak. This difference was explained before, and it could be related to a period of higher nutritional and physiological demand by the bird in its second cycle.

Conclusion

Alternative methods of feed restriction, like a reduction of 75% of daily feed amount or the use of diet with 75% of rice hulls, can substitute the conventional method for inducing molt in Hy-Line Brown layers, without modifying the performance in the second lay cycle;

This study was approved by the bioethics committee CETEA/UDESC, protocol number 1.39.11 and was conducted in accordance with the technical standards of biosafety and ethics.

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