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Effect of weight loss on the regression of the reproductive organs of quail Italian induced to molt

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Abstract

This study aimed to evaluate the effect of body weight loss (BWL) on regression of reproductive organs in Italian quails (*Coturnix coturnix*) submitted to forced moult by two methods. Eighty-four Italian quails (40 week old) were submitted to forced moult by the method of Zinc oxide (ZnO), or fasting (F) in order to obtain the following levels of BWL: 5, 10, 15, 20, 25, 30, and 35%. The control group consisted of six quails that were not submitted to

forced moult. The birds moulted by the ZnO method were fed with an egg laying ration added with 25000 ppm of ZnO while birds moulted by fasting were feed restricted. The quails were euthanized for organ collection as soon as they achieved the desired body weight loss. The results showed that there were no significant differences in ovary and oviduct regression between quails submitted to forced moult by both methods (F and ZnO) for high levels of body weight loss (30 and 35%). The body weight loss during forced moult was highly correlated with the regression of reproductive organs of Italian quails for both fasting and Zinc oxide methods. In order to obtain a satisfactory regression of ovary and oviduct the quails had to lose more than 30% of their initial body weight.

Keywords: Quail, Fasting, Zinc oxide

Efeito da perda de peso sobre a regressão dos órgãos reprodutivos de codornas Italianas induzidas a muda

Resumo

O objetivo desse trabalho foi avaliar o efeito da perda de peso corporal (PPC) sobre a involução do aparelho reprodutor de codornas variedade italiana (*Coturnix coturnix*) submetidas à dois métodos de muda forçada. Um total de 84 codornas (40 semanas de idade) foram submetidas à muda forçada pelo método de óxido de zinco (ZnO) ou método do jejum (F) a fim de se obter os seguintes níveis de PPC: 5, 10, 15, 20, 25, 30 e 35%. O grupo controle foi constituído de seis codornas as quais não sofreram muda forçada. Para a indução à muda, as aves do grupo ZnO foram alimentadas com ração de postura adicionadas de 25.000 ppm de óxido de zinco e as codornas do grupo F foram submetidas à restrição total do alimento. Ao atingir a PPC desejada em cada tratamento, as codornas foram sacrificadas para a coleta dos órgãos reprodutivos. Os resultados mostraram que nos grupos induzidos as maiores PPC (30% e 35%) não houve diferenças significativas em relação à involução do ovário e oviduto em todos os parâmetros observados. A perda de peso

corporal durante a muda foi altamente correlacionada com a regressão dos órgãos reprodutivos de codornas italianas para o método do jejum e óxido de zinco. A fim de obter uma regressão satisfatória do ovário e oviduto as codornas devem perder no mínimo 30% ou mais do seu peso corporal inicial.
Palavras-chave: Codornas, zinco, jejum

1. Introduction

It is observed that there is an egg production reduction as laying hens get older with detrimental effects to internal and external egg quality (Murakami et al., 2005). This occurrence is related to the end of laying cycle, i.e. the natural moulting, which can last for a long period with low egg production. In this situation, the hens are not profitable and are sold by the producer before they reach this period (Berry, 2003). An alternative to end of cycle laying hens is the use of forced moulting. This practice aims to recycle the flocks into a new productive lying cycle with improvement in egg production (Bell, 2003).

Lipids accumulated in the shell gland over the first egg laying cycle interfere on Calcium deposition leading to defective eggshells (Buxadé and Flox, 2000). The forced moulting enables the restoration of reproductive organs and by their regression the shell gland lipids are removed (Cardoso, 1996). According to Heryanto et al. (1997), the regression of the oviduct not only reduces cells or tissue size but it allows a truly tissue remodelling. The apoptosis process removes cells from the glandular tissue during the regression and after birds are forced moulted new cells with optimized functionality appear.

The regression of reproductive organs is related to the body weight loss (BWL) achieved during the forced moult (Teixeira et al., 2006). Many studies aim to determine the amount of weight loss that is required to optimize the post moult egg production. The scientific literature report ranges from 15 to 40% of BWL in order to allow the restoration of reproductive system (Ruszler, 1998). However, according to Brake (1993) and Berry (2003), only levels

above 25% are adequate to promote lipids removal from shell gland and a complete regression of ovary.

Different forced moulting methods have been studied but the fasting is the most applied (Ruzler, 1998) due to its convenience and low cost (Hussein, 1996). However, this method is highly criticized by animal welfare organizations around the world (Bell and Kuney, 2004). Many studies conclude that the use of Zinc oxide method is an efficient alternative to fasting (Breeding et al., 1992; Ruszler, 1998; Alodan and Mashaly, 1999; Ramos et al., 1999). Information about forced moulting effects on reproductive system in Japanese quails is scarce with few studies (Garcia et al., 2001; Teixeira et al., 2007) being still necessary to determine which BWL is needed for a good post moult performance in this species (Mesquita Filho, 2008). Currently there is no study that addresses forced moult in Italian quails in the literature. This study aims to evaluate the effect of body weight loss on regression of reproductive organs in Italian quails (*Coturnix coturnix*) submitted to forced moult.

2. Material and Methods

A total of 90 Italian quails at 40 weeks of age (end of the first production cycle) were housed in the facilities of the Veterinary Faculty at Universidade Estadual do Ceara. All quails were individually weighed, identified and placed in commercial battery cages with a 106 quail/m^2 density.

2.1 Experimental groups

All quails (n=90) were divided into 15 groups according to the treatment with six birds each. The control group (C) consisted of quails that were not submitted to forced moult, this way presenting 0% of body weight loss (BWL).

The birds forced moulted by fasting (F) were divided into the following groups according to the desired BWL: F5, F10, F15, F20, F25, F30, and F35.

The quails forced moulted by the use of Zinc oxide (ZnO) were divided into groups according to the BWL as follows: ZnO5, ZnO10, ZnO15, ZnO20, ZnO25, ZnO30, and ZnO35.

2.2 Treatments

The birds were submitted to forced moult using the method of Zinc oxide (ZnO), or fasting (F) in order to obtain the following levels of BWL: 5, 10, 15, 20, 25, 30, and 35%. The birds moulted by the ZnO method were fed with an egg laying ration added with 25000 ppm of ZnO while birds moulted by fasting were feed restricted. All birds were given access to water *ad libitum*. The duration of forced moult treatment was highly variable among the experimental groups since it was directly related to the achievement of the desired pre determined BWL levels. It varied from 12h for BWL of 5% up to 8 days for BWL of 35%.

According to the experimental groups, as the quails achieved the desired BWL they were euthanized by cervical dislocation and the reproductive system was collected. The organs were weighed with a precision scale (0,001g) and percentages of regression were obtained by comparison with measurements from the control group.

The following variables were evaluated: a) pre and post moult body weight (g); b) weight regression of ovary, oviduct and complete reproductive system (%); c) weight ratio between ovary, oviduct or reproductive system with body weight (%); d) correlation between BWL and weight of ovary and oviduct. The variables in a), b) and c) were evaluated in the following groups: C, F25, F30, F35, ZnO25, ZnO30, and ZnO35. The variables in d) were evaluated in all groups.

2.3 Statistical Analysis

The data was analyzed for normality by Shapiro-WilK e Kolmogorov-Smirnov tests. The treatment means were compared by Kruskall-Wallis and the means were significantly different when $p<0.05$. The statistical analyses were performed by SAS (1999).

The relationship between BWL and ovary or oviduct weight was evaluated by the correlation of Pearson (r) and by analysis of polynomial regression (R^2) through the software Excel.

3. Results and Discussion

Table 1 presents the initial body weight, final body weight and body weight loss of Italian quails submitted to forced moult.

Table 1. Initial body weight, final body weight and body weight loss (BWL) of Italian quails submitted to forced moult using the Zinc oxide (ZnO) method or fasting (F).

Group	Initial body weight (g)	Final body weight(g)	BWL (%)
Control	306,42 ± 17,92	306,42 ± 17,92	-
F25	310,58 ± 33,65	233,00 ± 25,35	24,98 ± 1,48
F30	299,08 ± 36,67	208,08 ± 26,11	30,42 ± 1,66
F35	298,00 ± 30,60	193,58 ± 20,87	35,06 ± 1,14
ZnO25	297,33 ± 15,32	220,72 ± 12,31	25,04 ± 0,72
ZnO30	293,08 ± 26,37	221,17 ± 50,46	30,18 ± 0,96
ZnO35	307,25 ± 22,09	199,58 ± 18,68	35,11 ± 1,98

The mean of initial body weight varied between 293,08g and 310,58g that is the range of weight normally observed in Italian quails. The literature about forced moult in quails is most frequently related to Japanese quails, a different strain which body weight varies between 134,13g and 188,17g (Garcia et al., 2001; Teixeira et al., 2007; Faitarone et al., 2008; Mesquita Filho, 2008).

Bird strain can affect the forced moult performance due to differences in initial body weight related to the characteristics of the strain (Ruszler, 1998). Cupertino (2006) observed that in the Poultry Industry, semi-heavy layers have body weight 10% heavier than light birds, and according to Albano Junior et al. (2000), light layers and semi-heavy layers presented different performances during the post moult period.

Table 2. Ovary and oviduct regression of Italian quails submitted to different levels of body weight loss (BWL)

Group	**Ovary**			**Oviduct**		
	(g)	Regression (%)	Ovary (%)	(g)	Regression(%)	Oviduct (%)
C	7,80 ± 1,54^{a}	-	2,54 ± 0,47^{a}	10,71 ± 1,07^{a}	-	3,50 ± 0,37^{a}
F25	3,33 ± 1,05^{ab}	57,29± 13,43^{c}	1,42 ± 0,41^{b}	6,05 ± 0,79^{b}	43,46 ± 7,40^{b}	2,61±0,33^{b}
F30	1,11 ± 0,67^{c}	85,70 ± 8,65^{ab}	0,52 ± 0,31^{c}	3,07 ± 0,87^{c}	71,33 ± 8,12^{a}	1,48±0,40^{c}
F35	0,66 ± 0,17^{c}	91,47 ± 2,21^{a}	0,35 ± 0,10^{c}	2,92 ± 1,22^{c}	72,72 ±11,44^{a}	1,51±0,63^{c}
ZnO25	2,84 ± 2,31^{b}	73,75 ± 17,85^{bc}	0,90 ± 0,57^{b}	5,23 ± 2,15^{b}	51,14 ±20,13^{b}	2,36±0,95^{b}
ZnO30	1,10 ± 0,55^{c}	85,90 ± 7,09^{ab}	0,52 ± 0,30^{c}	3,00 ± 1,72^{c}	72,00± 16,06^{a}	1,45 ± 0,90^{c}
ZnO35	0,81 ± 0,50^{c}	89,54 ± 6,44^{a}	0,40 ± 0,21^{c}	2,63 ± 0,53^{c}	75,46 ± 4,94^{a}	1,32 ± 0,30^{c}

Means in the same column with different superscript differ significantly ($p<0.05$)

Table 2 shows the ovary and oviduct regression of Italian quails submitted to different levels of body weight loss. The groups that were induced to 30% and 35% of BWL did not present significant differences related to ovary and oviduct regression in none of the variables analyzed. However, ovary weight was higher in the group F35 when compared to the group ZnO35.

Quails with 25% of BWL presented significant ovary and oviduct regressions though the regressions observed in the groups with 30% and 35% of BWL were higher. This result disagrees with the research of Teixeira et al., (2007) that studied forced moult with the Zinc oxide method in Japanese quails verified that the birds with BWL of 25% could reach good levels of ovary (92,15%) and oviduct (73,53%) regression.

According to Berry (2003), in commercial layers 25% of body weight loss using the fasting promoted a complete ovary regression. Landers et al., (2005) evaluated light layers submitted to forced moult using the fasting, with approximate BWL of 24%, and they observed a decrease in the ovary weight from 36,5g to 6,2g which means 83,01% of ovary regression. The same authors tested a diet with alfalfa and observed a lower body weight loss (18,9%) for a higher ovary regression (86,02%) when compared to the fasting treatment.

Only the birds submitted to a BWL higher than 30% had presented an ovary regression over 85% in this research. Souza et al., (2006), studying three types of feed restriction during 14 days, observed an approximate ovary regression of 78% and verified that they needed to increase the period of the treatment in order to obtain more regression of the reproductive system and, as consequence, a better post moult performance. The increase in the length of the treatment would mean a higher induction for body weight loss in order to achieve an ideal ovary regression.

The birds before the forced moult presented an oviduct weight /body weight relation of 3,50%. The values of oviduct weight/BW (%) were significantly lower in the groups with BWL of 30% and 35% when compared to the group with 25% of BWL. The lowest oviduct weight/BW ratio was 1,32% in the group ZnO35. These values were higher when compared to those obtained for Berry and Brake (1991). These authors submitted commercial layers to 30% of BWL using forced moult with Zinc (2%) and fasting. They have found an oviduct/body weight ratio of 1,18% and 0,95%, respectively. The same pattern happened to ovary percentage. The groups with 30% and 35% of BWL presented no significant difference in their ovary /body weight ratio (%), however they presented lower ovary/body weight ratio when compared to the quails that reached 25% BWL. However the ovary percentages in this study were higher than those found by Souza et al., (2010). These authors applied a qualitative feed restriction of 50% for 15 days and obtained an ovary percentage of 0,30% even with birds loosing only 25% of body weight. The

higher proportion of reproductive tract of quails compared to chickens can be explained by the different in size. The smaller the bird the bigger the reproductive tract proportionally. Teixeira et al., (2007) submitted that Japanese quails to forced moult by fasting and Zinc oxide. Japanese quails are lighter than Italian quails and achieved higher levels of reproductive tract regression when compared to this study.

Table 3. Reproductive system weight (g), regression of reproductive system (%) and ratio between reproductive system and total body weight of Italian quails submitted to forced moult by fasting (F) or Zinc oxide method (ZnO).

Group	Reproductive system weight (g)	Weight regression reproductive system (%)	Reproductive system (%)
Control	18,51 ± 2,44^{a}	-	6,04 ± 0,76^{a}
F25	9,39 ± 1,83^{ab}	49,29 ± 9,88^{b}	4,03 ± 0,69^{ab}
F30	4,19 ± 1,49^{c}	77,39 ± 8,03^{a}	2,00 ± 0,65^{c}
F35	3,59 ± 1,39^{c}	80,62 ± 7,50^{a}	1,85 ± 0,71^{c}
ZnO25	8,07 ± 4,35^{b}	56,39 ± 23,50^{b}	3,65 ± 2,00^{b}
ZnO30	4,10 ± 2,21^{c}	77,86 ± 11,92^{a}	1,97 ± 1,19^{c}
ZnO35	3,44 ± 0,88^{c}	81,39 ± 4,76^{a}	1,73 ± 0,40^{c}

Means in the same column followed by different superscripts differ significantly ($p<0.05$)

Table 3 shows the reproductive system weight (g), regression of reproductive system (%) and ratio between reproductive system and total body weight of Italian quails submitted to forced moult by fasting (F) or Zinc oxide method (ZnO). Among the groups that achieved high levels of body weight loss (30 or 35%), the higher levels were found in quails with 35% BWL, however there was no significant difference compared to quails with 30% BWL. Among the treatment that promoted 25% of BWL only the group F25 did not present significant differences of relative and absolute weight of reproductive tract comparing to the control group. This result diverges from the findings of Garcia et al. (2001) who submitted Japanese quails to 3 days of fasting and observed 25,64% of BWL and 31,67% of reproductive system regression, with significant differences compared to quails not submitted to moult.

The figures 1 and 2 show the regression equation and coefficient of determination (R^2) between the ovary and oviduct weight and body weight loss (%) of quails submitted to forced moult by the use of Zinc oxide (yZnO) and fasting (yF), respectively.

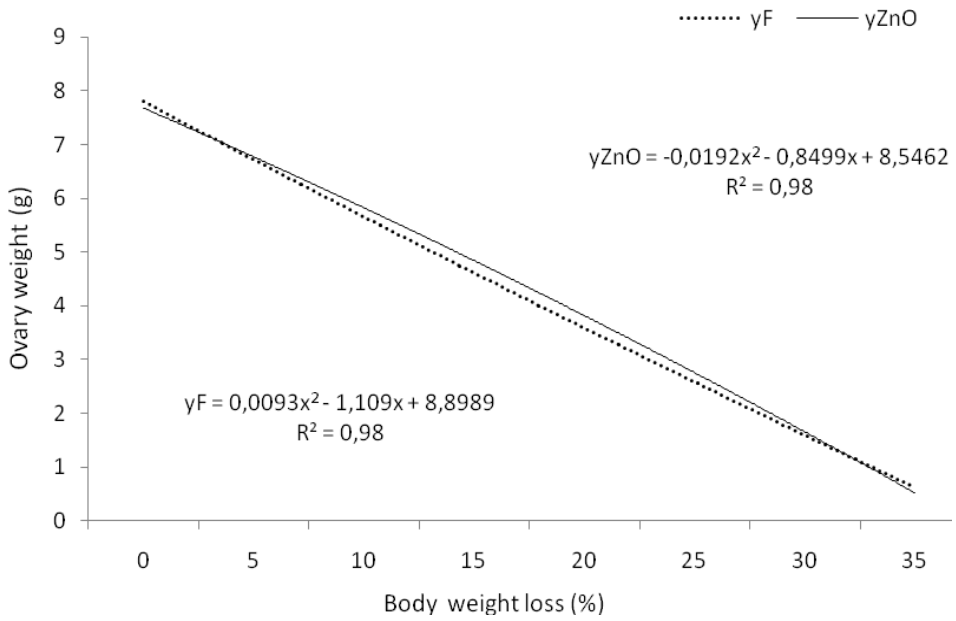

Figure 1. Regression equation and coefficient of determination (R^2) between the ovary weight and body weight loss (%) of quails submitted to forced moult by the use of Zinc oxide (yZnO) and fasting (yF).

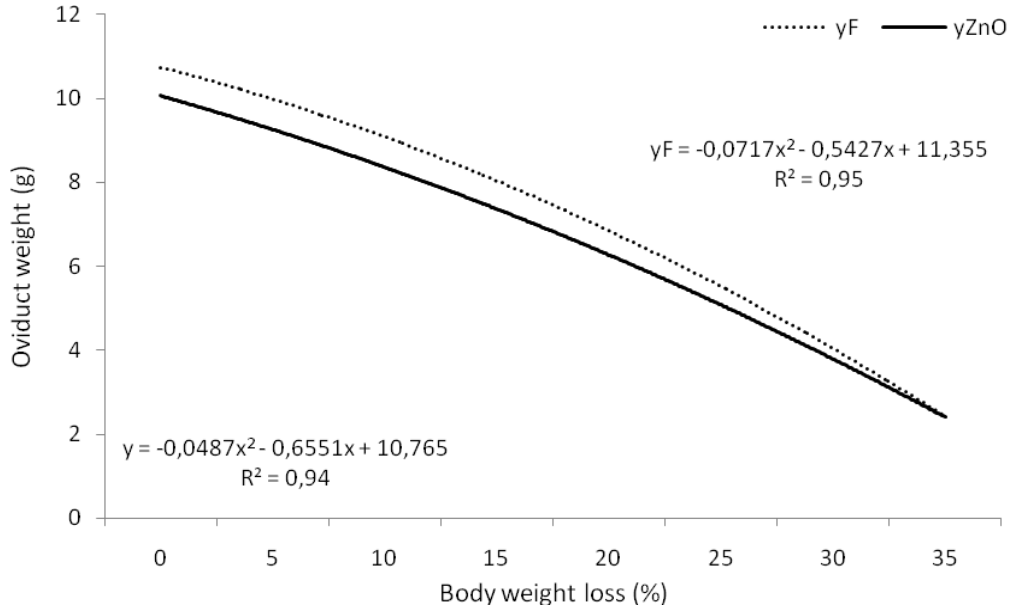

Figure 2. Regression equation and coefficient of determination (R^2) between the oviduct weight and body weight loss (%) of quails submitted to forced moult by the use of Zinc oxide (yZnO) and fasting (yF).

The correlation between ovary weight and body weight loss was high for both fasting (r=-0,99) and Zinc oxide (r=-0,99). There was also a high correlation between oviduct weight and BWL for both fasting (r=-0,97) and Zinc oxide (r=-0,96).

The results show strong relations to ovary ($yZnO = -0,0192x^2 - 0,8499x + 8,5462$, $R^2=0,98$ and $yF = 0,0093x^2 - 1,109x + 8,8989$, $R^2=0,98$) and oviduct ($yZnO = -0,0487x^2 - 0,6551x + 10,765$, $R^2=0,94$ and $yF = -0,0717x^2 - 0,5427x + 11,355$, $R^2=0,95$).

According to Garcia (2001), the pioneers in studying the regression of reproductive organs in laying hens through pharmacological methods were Smith et al., (1957) that did not find correlation between ovary and oviduct weight with body weigh. Bertechini and Geraldo (2005) reported that the initial

reduction of ovary weight is independent of the level of body weight loss. In our study the results showed that ovary and oviduct weight are highly correlated to the body weight of Italian quails submitted to forced moult by the use of Zinc oxide and fasting. These findings are in agreement with Ovejero (1995) that reported that the main condition to determine the length of forced moult is the achievement of the desired level of body weight loss, since this is highly related to the regression of ovary and oviduct.

Conclusion

The body weight loss was highly correlated with the regression of reproductive organs of Italian quails for both fasting and Zinc oxide methods, with potential use as a reference of the time needed for the duration of treatment. In order to obtain a satisfactory regression of ovary and oviduct the quails had to lose a minimum 30% of their initial body weight.

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