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Quantitative feed restriction from 35 to 42 days of age for broiler chickens

Restrição alimentar quantitativa dos 35 aos 42 dias de idade para frangos de corte

BORTOLUZZI, Cristiano[1*]; FERNANDES, Jovanir Inês Müller[2]; CONTINI, Jean Paulo[2]; GURSKI, Tiago Jacob[2]; ESSER, Aline Fernanda Gonçalves[2]; PROKOSKI, Karen[2]

[1]Universidade de São Paulo, Escola Superior de Agricultura Luiz de Quieroz, Piracicaba, São Paulo, Brasil.
[2]Universidade Federal do Paraná, Setor Palotina, Palotina, Paraná, Brasil.
*Endereço para correspondência: bortoluzzi.c@gmail.com

SUMMARY

The objective of this study was to evaluate the effect of increasing levels of feed restriction in broilers aged from 35 to 42 days, on the performance, carcass parameters and intensity of lesions at slaughter. A total of 1,225 one-day old chicks were obtained from a commercial hatchery and were grown over a 34-days period (five weeks). At 34 days of age all birds were weighed and redistributed into a completely randomized design to perform the following treatments: control (0% feed restriction), 10, 20, 30 or 40% feed restriction. The amount of feed given to animals was adjusted daily according to the previous day's intake of the control treatment. At 42 days, birds were weighed and two birds per pen were slaughtered, one to evaluate carcass yield and cuts and the other for body composition analysis. Weight gain and feed intake were decreased linearly ($p<0.05$) according to increasing levels of restriction, while the feed:gain ratio showed a quadratic effect ($p<0.05$). The hot eviscerated carcass weight decreased linearly ($p<0.05$) according to increasing levels of restriction, without effects on the carcass, breast and thigh yield. The dry matter and fat of the carcass decreased and the crude protein increased ($p<0.05$), according to levels of restriction. We conclude that feed restriction of 2.5% in the last week of life can improve the feed efficiency of poultry, when there is a higher accumulation of fat in the carcass.

Keywords: body composition of chickens, carcass yield, feed management

RESUMO

O objetivo deste trabalho foi avaliar o efeito de níveis crescentes de restrição alimentar dos 35 aos 42 dias de idade de frangos de corte sobre o desempenho, características de carcaça e intensidade de lesões na carcaça no momento do abate. Um total de 1225 pintainhos de um dia de idade foram alojados aleatoriamente em boxes e alimentados *ad libitum* por 5 semanas. Aos 34 dias de idade as aves foram pesadas e redistribuídas em um delineamento inteiramente aleatorizado e submetidas a 0 (controle), 10, 20, 30 ou 40% de restrição alimentar. A quantidade de ração fornecida aos animais foi ajustada diariamente, de acordo com o consumo do tratamento controle. Aos 42 dias as aves avaliou-se o rendimento de carcaça e cortes, além da composição bromatológica corporal. Houve efeito linear decrescente sobre o ganho de peso e o consumo de ração ($p<0,05$) de acordo com os tratamentos, enquanto que sobre a conversão alimentar houve efeito quadrático ($p<0,05$). O peso da carcaça eviscerada quente diminuiu linearmente ($p<0,05$) de acordo com o aumento dos níveis de restrição, sem afetar o rendimento de carcaça e peito. Com relação aos dados de composição da carcaça verificou-se que a matéria seca e a gordura da carcaça decresceram enquanto que a proteína bruta aumentou ($p<0,05$). Conclui-se que o nível de 2,5% de restrição é capaz de melhorar a eficiência alimentar das aves na última semana de criação, período em que tem-se maior acúmulo de gordura na carcaça.

Palavras-chave: composição corporal de frangos, manejo alimentar, rendimento de carcaça

INTRODUCTION

Quantitative or qualitative feed restriction for broilers can improve the feed:gain ratio, decrease incidence of metabolic diseases and fat deposition in broiler carcasses. In addition, such restriction can reduce feed costs, either by avoid wastage (SAHRAEI, 2012) or, according to Fontana et al. (1993), to reduce costs, when feed efficiency is low, without reducing slaughter weight. These authors report that dietary restriction can reduce the cost of the starting diet in 22%.

Chickens fed *ad libitum* can consume twice or thrice the amount of energy required for maintenance (YU & ROBINSON, 1992). Thus, limiting the metabolizable energy (ME) intake may reduce the abdominal fat yield, as verified by Zhan et al. (2007), although a reduction in carcass and breast yield was also observed. Fat deposition, on the other hand, can cause rejection of the meat by consumers and cause difficulties in processing (SAHRAEI, 2012).

Several studies have evaluated the effects of feed restriction on performance and carcass yield of broilers (CAMACHO et al., 2004; ZHAN et al., 2007). According to Rosa et al. (2000), the best age for restriction is between the second and third week of age, because before 7 days of age the restriction may cause underdevelopment of the gastrointestinal tract and a decrease in productive performance of broilers. If the restriction occurs after the 21st day, broilers will not have enough time to recover the weight loss (ROSA et al., 2000).

In a recent review, Sahraei (2012) described some forms of feed restriction, such as physical feed restriction, skip-a-day feeding, lighting programs, diet dilution, use of low protein or low energy diets and chemical methods. However, the quantitative restriction has also been a topic of research (SUGETA et al., 2002; URDANETA-RINCON & LEESON, 2002). A study suggested that if the weight loss at the end of the restriction period is between 11 and 12% compensatory gain will probably occur (ROSA et al., 2000).

This work was conducted to study the effects of increasing levels of feed restriction on 35 to 42-days-old-chickens, on the productive performance, carcass yield and composition, and incidence of scratches in 42-days old broiler carcasses.

MATERIAL AND METHODS

All procedures for animal husbandry and collection of biological material were approved by the Ethics Committee on the Use of Experimental Animals of the Federal University of Paraná - *Sector* Palotina, considering that the experimental trial met the ethical principles in animal testing, as recommended by the Brazilian College of Animal Experimentation.

A total of 1,225 one-day-old male Cobb chicks were housed in the experimental Poultry House of the Federal University of Paraná - *Sector* Palotina, Parana State. For the first 34 days of rearing, all birds received commercial feed, formulated to meet the requirements of each phase, *ad libitum*, according to Brazilian Tables (ROSTAGNO et al., 2011). At 34 days, 1050 broilers were weighed and redistributed into a completely randomized design, in 5 treatments and 7 replicates, totaling 35 experimental units with 30 birds/pen.

Treatments used in the period from 35 to 42 days of age consisted of increasing levels of feed restriction, as follows: T_1: control treatment, that is, without feed

restriction and T_2, T_3, T_4 and T_5 with 10, 20, 30 and 40% restriction, respectively, based on the feed intake of the control treatment, *ad libitum* (*pair-feeding*). The amount of feed was adjusted daily, by adding or removing feed in accordance with the feed intake of the treatment T_1. The performance was obtained by weighing birds at the beginning and at the end of the period and also through feed intake during the week (Table 1).

Table 1. Composition and calculated contents of the experimental diet

Item (%)	Finisher
Corn	62.56
Soybean meal	29.80
Soybean oil	4.60
Dicalcium phosphate	0.80
Limestone	0.95
Salt	0.37
DL-Met	0.30
L-Lysine.HCl	0.21
L-Threonine	0.06
Vitamin Premix[1]	0.06
Mineral Premix[2]	0.05
Choline chloride (60%)	0.05
Total (kg)	100
Calculated composition	
MEn(kcal/kg)	3150
Crude Protein (%)	19.00
Digestible Lys (%)	1.010
Digestible Met+cys (%)	0.737
Digestible Met(%)	0.463
Digestible Thr (%)	0.656
Calcium (%)	0.638
Available Phosphorus (%)	0.298
Sodium (%)	0.195

[1]DSM Nutritional Products, Provided per kilogram of product: Vit. A = 9,000,000 UI; Vit. D_3 = 2,500,000 UI; Vit. E = 20,000 UI; Vit. K_3 = 2,500mg; Vit. B_1 = 2,000mg; Vit. B_2 = 6,000mg; Vit. B_6 = 3,000mg; Vit. B_{12} = 15,000µg; Niacin = 35g; Pantothenate = 12g; Biotin -100mg; Folic acid = 1,500mg; Se = 250mg.
[2]DSM Nutritional Products, Provided per kilogram of product: Mn = 160,000mg; Fe = 100,000mg; Zn = 100,000mg; Cu = 20,000mg; Co = 2,000mg; I = 2000mg.

At 42 days of age, one broiler from each experimental unit was killed by cervical dislocation to evaluate carcass yield, cuts, abdominal fat and intensity of scratches on the carcass after fasting for 6 hours. Carcass yield was obtained by the weight of the carcass without feathers, entrails and feet in relation to body weight. In addition, for the analysis of carcass composition, one bird from each replicate was slaughtered and frozen, after fasting for 24 hours. Later, the whole carcass was ground and dried at 55°C for 72 hours and then ground in knife type mill. The protein content was obtained by the method of Microkjeldahl (BRASIL, 1981). The ether extract was obtained by the method of Soxhlet (BRASIL, 1981).
The data was analyzed using SAS software package (STATISTICAL ANALYSIS SYSTEM, 2006). For the analysis of variance, the assumption of normality was previously checked. The factors showed a normal distribution, allowing to perform a parametric procedure of analysis of variance considering 5% of significance level. When effects of the restriction levels were observed, a regression analysis was run, where the linear and quadratic polynomial models were analyzed. To analyze the intensity of lesions the Chi-Square Test was used.

RESULTS AND DISCUSSION

There is little information about feed restriction to broilers during their last week of life. Zhan et al. (2007) showed that compensatory growth occurs when chickens are submitted to early feed restriction; suggesting that this kind of management does not interfere with production parameters. However, we hypothesize that feed restriction during the last week may be beneficial to

performance and carcass parameters, because by reducing feed intake, the birds can reduce energy intake and deposition of fat in the carcass at market age.

Levels of feed restriction influenced quadratically both body weight and feed:gain ratio in birds ($p<0.05$). On the other hand, body weight gain and feed intake decreased linearly according to the levels ($p<0.05$). Body weight gain reduced 5, 17, 31 and 43% according to the increasing levels of feed restriction, respectively. Therefore, according to the equation (Table 2), 2.5% of feed restriction in the last week of life, can improve the feed:gain ratio and this can be economically important considering the high cost of broiler feed.

Table 2. Performance of broilers from 35 to 42 days of age subjected to increasing levels of feed restriction

Treatments	Body weight (g)	Body weight gain (g)	Feed intake (g)	Feed:gain ratio (g/g)
	42 days		35-42 days	
ad libitum	3,177	954	1,819	1.92
Restriction				
10%	3,112	909	1,719	1.90
20%	3,076	793	1,588	2.01
30%	2,970	655	1,424	2.19
40%	2,732	547	1,301	2.42
Means	3013.43	771.58	1570.31	2.09
Regression	Quadratic[1]	Linear[2]	Linear[3]	Quadratic[4]
CV (%)	4.09	5.93	10.94	8.21

[1]$Y = 3.161+1.70x-0.3014x^2$ R_2:0.64; [2]$Y = 1092.1-106.83x$ R_2:0.98; [3]$Y = 1,826-10.94x$ R_2:0.82; [4]$Y = 1.9020-0,004x+0,0004x^2$ R_2:0.60.

Considering a hypothetical example with the results of this study, where the feed intake in the treatment control was 1,819g/animal on 35 to 42 days and considering a level of feed restriction of 2.5%. In a company that slaughter 300,000 broilers/day, the company can save 95,000kg of feed/week, i.e., 13,570kg of feed/day. If the cost of feed it is around US$0.40/kg the company can save US$35,600/week or, US$1,852,500/year, without affect the feed:gain ratio, showing the great impact of this kind of management.

Besides, the intensity of feed restriction may be crucial to the success of this management, which aims mainly to reduce feeding costs. Regardless of age at which chickens were subjected to feed restriction, the higher level can decrease the performance, i.e., at high levels of restriction chickens cannot exhibit compensatory growth (SANTOSO, 2002; SUGETA et al., 2002; SALEH et al., 2005). Despite of this, Saleh et al. (2005) found better feed:gain ratio of chickens after restriction, including total periods that lasted up to 63 days of age. Although in most studies feed restriction is applied in the early stages of life, we believe that the quantitative restriction in the week before broilers are slaughtered (35-42 days), can provide some beneficial results, mainly because in this phase the feed efficiency is lower.

Another objective in applying feed restriction is to improve carcass

properties, decreasing fat deposition (ZHAN et al., 2007). There are studies showing for instance that feed restriction decreases fat deposition in the liver and carcass of broilers (CORNEJO et al., 2007; YANG et al., 2009). On the other hand, Yang et al. (2009) showed that depending on the king of restriction, lower breast yield may occur.

In our study, a decreasing linear effect on the weight of the hot eviscerated carcass was observed ($p<0.05$) - (Table 3). Similar results were found by Sugeta et al. (2002) where different programs of feed restriction decreased the carcass weight compared to broilers fed *ad libitum*. Moreover, these authors reported no significant differences in the yield of carcasses and cuts, as also observed in this study.

Urdaneta-Rincon & Leeson (2002) highlighted that breast yield was more impaired than weight gain, in contrast to the results of this work. However, breast yield deserves greater attention in feed restriction programs due to its economic relevance (BUTZEN et al., 2013). In our study, we observed that when the birds were submitted to 40% of feed restriction the breast yield was 3% lower than the treatment fed *ad libitum,* although the carcass weight was 15% lower.

Table 3. Carcass yield of broilers at 42 days of age subjected to increasing levels of feed restriction

Treatments	Carcass (g)	Carcass (%)	Breast (%)	Thigh (%)	Severe lesions (%)
ad libitum	2517.14	79.24	37.13	25.86	11.11
Restriction					
10%	2446.57	78.63	36.90	26.00	16.67
20%	2427.71	78.92	35.43	26.06	27.78
30%	2339.14	78.77	35.04	26.41	33.33
40%	2127.14	77.87	35.70	26.90	11.11
Average	2371.54	78.69	36.04	26.25	-
Regresion	Linear[1]	NS	NS	NS	-
Chi-Square	-	-	-	-	0.1096
CV(%)	4.01	1.48	5.59	4.68	-

[1]Y= 2561.31-0.28x R^2 = 0,61; NS = not Significant; CV = coefficient of variation.

Relative to the intensity of carcass lesions (Table 3), no relationship was found between feed restriction level and severity of lesions ($p<0.05$). Despite the subjectivity of this assessment, which requires a larger sample of chickens to observe significant differences between treatments, it is important, because when broilers are subjected to feed restriction, the possibility of scratching may increase during the refeeding period and, this can lead to poorer carcass quality, mainly due to carcass contamination.

More severe levels of feed restriction tend to decrease the amount of body fat (SUGETA et al., 2002). Nevertheless, many contradictory studies have been verified in the literature concerning body fat deposition (SAHRAEI, 2012). In our study, with increasing intensity of feed restriction, carcass crude protein increased linearly, while fat declined ($p<0.05$) - (Table 4), similarly to Zhan et al. (2007). Furthermore, when

chickens grow older, body fat tends to increase and the protein percentage tends to decrease (SUGETA et al., 2002). This is particularly important, due to inefficiency of protein deposition caused by age, the final phase is ideal to perform feed restriction.

Table 4. Carcass composition of broilers submitted to feed restriction from 35 to 42 days old

Treatments	Dry matter (%)	Crude Protein (%)	Ether Extract (%)
		42 days	
ad libitum	34.05	49.10	38.25
Restriction			
10%	34.02	49.42	38.44
20%	33.55	49.38	35.81
30%	32.89	51.12	34.24
40%	32.80	52.46	33.27
Mean	33.46	50.29	36.00
Regression	Linear[1]	Linear[2]	Linear[3]
CV(%)	3.11	4.86	6.58

[1]Y= 34.19-0.03x R^2 = 0.18; [2]Y= 48.83+0.07x R^2 = 0.15; [3]Y= 38.94-0.14x R^2 = 0.42.

Feed restriction programs, during the final phase, can be used to improve the performance of broilers, but the level should be carefully evaluated, to avoid lower performance of the birds. We conclude that by restricting the feed intake of broilers in 2.5% during the last week, it is possible to obtain beneficial results on the performance without affecting the yield of carcass and breast. Furthermore, the savings from the feed restriction is one of the factors that should be considered for appropriate decision making.

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