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Effect of early feed restriction on body weight and compensatory growth in *Label Rouge* broiler chickens

Efecto de la temprana restricción alimenticia en el peso corporal y crecimiento compensatorio en pollos de engorde *Label Rouge*

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Abstract

This research was conducted to assess the compensatory gain in birds that have suffered severe food restriction and a reduced growth in its initial phase. A total of 144 birds were used in the *Label Rouge* lineage with average initial weight 239.90 ± 76.80 g, from 28 to 49 days. The experimental design used was a completely randomized design, where the birds were distributed in 18 boxes, containing 3 treatments and 6 replicates of 8 birds per cage. The treatments were as follows: birds with body weight of 150.73 ± 12.62 g, between weighing from 239.79 ± 13.14 g and heavy weight of 329.17 ± 24.89 g in different periods, from 28 to 35, 35 to 42 and 42 to 49 days of age, respectively. In relation to weight gain, the heavy birds, obtained better results when compared to the other. The feed consumption has changed in the three periods and, in the period of 42 to 49 days, the treatments did not differ among themselves. Feed conversion rates (p = 0.127) and feasibility (p = 0.6163) of birds do not differ in different periods.

Keywords: Consumption, feed efficiency, poultry, severe restriction.

Resumen

Esta investigación se realizó para evaluar la ganancia compensatoria en aves que han sufrido graves restricciones alimenticias y un crecimiento reducido en su fase inicial. Se utilizó un total de 144 aves en el linaje *Label Rouge* con un peso inicial promedio de 239.90 ± 76.80 g, de 28 a 49 días. El diseño experimental utilizado fue el diseño completamente al azar, en el que las aves se distribuyeron en 18 cajas, con 3 tratamientos y 6 repeticiones de 8 aves por jaula. Los tratamientos fueron los siguientes: aves con peso corporal de 150.73 ± 12.62 g, entre el peso de 239.79 ± 13.14 g y peso de 329.17 ± 24.89 g en diferentes períodos, de 28 a 35, 35 a 42 y 42 a 49 días de edad, respectivamente. En relación al aumento de peso, las aves pesadas, obtuvieron mejores resultados en comparación con el otro. El consumo de alimento ha cambiado en los tres períodos y, en el período de 42 a 49 días, los tratamientos no difirieron entre sí. Los porcentajes de conversión alimenticia (p = 0.127) y de viabilidad (p = 0.6163) de las aves no difieren en diferentes períodos.

Palabras clave: Consumo, eficiencia alimentaria, aves de corral, restricción severa.

Introduction

The animal growth rate is genetically predetermined, following a conventional growth curve when conditions are favorable. Thus, birds which had achieved the body weight in a short period of time will have the feed efficiency improved due to a decreasing in their maintenance requirements (Leeson & Summers, 2005). For this reason, currently has aroused interest in the use of programs of food restriction to modify the pattern of growth, and reduce its maintenance requirement, seeking compensatory growth (Boostani, Ashayerizadeh, Mahmoodian, Fard & Kamalzadeh, 2010; Butzen Ribeiro, Vieira, Kessler, Dadalt & Della, 2013; Trocino, Piccirillo, Birolo, Radaelli, Bertotto, Filiou, Petracci & Xiccato, 2015). Compensatory growth refers to the abnormal rapid growth observed in animals of the same age and in the same lineage

that previously had restricted feeding (Butzen *et al.*, 2013).

During a period of restriction birds exhibit a low growth and a decreasing in the plasma concentrations of insulin-like growth factors (IGF-1 and II) (Leili, Buonomo, & Scanes, 1997; Kühn, Darras, Gysemans, Decuypere, Berghman & Buyse, (1996), which may explain this lower growth. When food availability is restored, the birds grow at a rate greater than usual to reach the normal weight for her age. This accelerated growth observed, when the period of food restriction is terminated, could be due to a higher level of concentration of growth hormone (GH) observed in birds that passed earlier by a food restriction (Buyse, Decuypere & Veldhuis, 1997).

In addition to these, other hormones are directly or indirectly involved in numerous lawsuits seeking recovery of animal performance. There are reports of rapid increase in plasma concentrations of insulin (Yambayamba, Price & Foxcroft, 1996) and triiodothyronine (T3) (Nir, Nitsan, Dunnington & Siegel, 1996).

In addition, the mechanisms involved in the growth process seem to be a compensation related to a requirement for reduced maintenance, an increasing in the food intake relative to body size, change the percentage of fat and protein deposited in the tissues, and/or an improvement of feed efficiency for growth (Rowan Srikandakumar, Englebright & Josey, 1996). In addition, the energy that sustains the fast growth can be caused by a reduction of the energy needs of general maintenance and/or a decreasing in basal metabolic rate observed in birds that have been through a period of food restriction (Zubair & Leeson, 1994).

Another advantage in reducing the initial growth in chickens is a decreasing in mortality caused by metabolic disorders and skeletal disorders, which had a great prominence in the modern strains selected for rapid growth (Lesson, 2007).

However, this method has been little applied aimed to had achieved an improvement in performance, due to the inconsistency of the research results related to feed intake and the occurrence or not of compensatory gain (Rosa, Ávila & Jaenisch, 2000). Given these concerns, the aim of this research was to analyze the compensatory gain in Label Rouge broiler chickens that had its growth development compromised under conditions of animal overcrowding.

Materials and methods

The experiment was conducted on Experimental unit at the Federal University of Mato Grosso, in the municipality of Santo Antônio do Leverger, Mato Grosso, Brazil. 144 birds were used the Label Rouge in the period from 28 to 49 days, which suffered severe food restriction in the first week of life and so had its development compromised. The experimental design used was a completely randomized design, where the birds were distributed in 18 cages, containing 3 treatments and 6 repetitions of 8 birds per box. The treatments were distributed, taking into account the age as follows: 28 to 35, 35 to 42 and 42 to 49 days of age, respectively, and their average weight, in birds with light weight, intermediate and heavy, where treatment 1 were housed birds with body weight of 150.73 ± 12.62 g, treatment 2 birds with intermediate weight weighing from 239.79 ± 13.14 g and treatment 3, contained the heavy birds weighing 329.17 ± 24.89 g.

The birds were weighed individually in a weekly interval, as well as the feed or feed leftovers in the period, with certain variables: weight gain (WG) (difference between the weight at the end of each period and the initial weight in the accommodation), relative gain (RG) (ratio between the average weight of the birds in the relevant period and the initial weight), relative weight (RW) (ratio between the weight of the birds and the average weight expected for each analyzed period), feed intake (FI) (difference between the total of rations provided and leftovers collected at the end of each period, based on the number of birds in the period), feed conversion (FC) (ratio between the total feed consumption and weight gain), uniformity (UNIF) (product of the average of the total weight of the birds body with a variation of ± 10%) and viability (VIAB) (product of all live birds at the end of the cycle x 100 divided by the total number of live birds at the beginning of the cycle).

The environmental conditions (temperature and relative humidity) were monitored daily (15h), by means of Thermo-hygrometer located in the center of the shed. At the end of the cycle were obtained the average temperature and humidity of the period.

The light programme was the continuous (24 hours of artificial light) throughout the experimental period. The feed used (Table 1) containing 19.50% PB and 3,100 kcal, was formulated in accordance with the nutritional requirements for broilers males average performance in growth phase I of 22 to 33 days of age (Rostagno, Albino, Donzele, Gomes, Oliveira, Lopes, Ferreira, de Toledo, Barreto & Euclides, 2011), from the previous phase, in an attempt to encourage compensatory gain with a ration of greater nutritional value than required at the age When they should be getting the feed to the

growth phase II, 34 to 42 days. During the trial period, the birds were given rations and water at will. Also the use of vitamin water aiming at to support the possible compensatory gain of broilers.

Table 1. Composition of the diet for broilers males average performance in growth phase I (22-33 days).

Ingredients ($g.kg^{-1}$)	
Corn	58.00
Soybean meal	37.03
Limestone	1.51
Vegetable oil	0.76
Dicalcium Phosphate	1.25
Salt	0.45
Mineral mixture + Vitamin*	1.00
	100
Analysis results	
Metabolizable Energy (MJ/kg)	3,100
Crude protein (%)	19.50
Calcium (%)	0.732
Available phosphorus (%)	0.342
Digestible phosphorus (%)	0.313
Methionine + Cistine (%)	0.787
Lysine (%)	1.078
Threonine (%)	0.701
Tryptophan (%)	0.194
Sodium (%)	0.200

*Composition / kg of the product: calcium (max) 210 g, calcium (min) 170 g, phosphorus (min) 50 g, Methionine (min) 22 g, vitamin A (min) 120000 U.I., vitamin D3 (min) 30000 U.I., vitamin E (min) 400 U.I., Thiamine (B1) (min) 35 mg, Riboflavin (B2) (min) 130 mg, Pyridoxine (B6) (min) 60 mg, Vitamin B12 (min) 300 mg, vitamin K3 (min) 30 mg, biotin (min) 1.6 mg, Folic Acid (min) 20 mg , Niacin (min) 680 mg, calcium pantothenate (min) 200 mg, choline (min) 400 mg, sodium (min) 26 g, manganese (min) 1600mg, zinc (min) 1380 mg, copper (min) 160 mg, iron (min) 630mg, iodine (min) 20 mg, selenium (min) 6 mg, Phytase (min) F.T.U. 10000, Avilamycin 200 mg, and Narasin + Nicarbazin 1000 mg + 1000 mg.

The results were analyzed using the software ASSISTAT ® for statistical analyses. Performance data (WG, RG, RW, FI, FC, UNIF and VIAB) were submitted to analysis of variance. Their means were compared by SNK (Student-Newman-Keuls test) at the 5% level of significance.

Results

By considering the information found in the literature, performed measurements of temperature and humidity (Table 2), as well as the birds behavior, can be concluded that these were exposed to stressful conditions during some periods of the day.

Table 2. Temperature and relative humidity (mean ± standard deviation) obtained in different periods of creation.

Period	Temperature (ºC)		Relative Humidity (%)	
	Maximum	Minimum	Maximum	Minimum
28 – 35 days	36.31 ± 0.9	22.09 ± 1.5	38.71 ± 15.0	21.86 ± 3.1
35 – 42 days	33.66 ± 1.3	21.29 ± 1.9	78.14 ± 10.1	36.29 ± 9.0
42 – 49 days	36.14 ± 1.4	24.20 ± 1.5	81.86 ± 14.6	42.57 ± 18.2

The average temperature during the assay period was 28.9ºC, the highest temperature was 0.9°C ± 36.31 registered in the first period (28 to 35 days), and the lowest, 21.29 ± 1.9°C, in the intermediate period (35 to 42 days). The average relative humidity was 49.9% during this period, with minimum occurrence of 21.86 ± 3.1% in the first week and a maximum of 81.86 ± 14.6% last week.

In the first week, 28 to 35 days, the lighter birds obtained the lowest gain in weight (102.40 g) and the heavy 83.05 g gain and 43.16 g, when compared to the intermediate and light birds, respectively (table 3).

From 35 to 42 days the difference in weight gain increased in 11.12 g and 0.9 g extra when compared to the previous period (table 3). In the last period there was no difference between intermediate and light birds ($p > 0.05$), and treatment with heavy birds was superior to the others (291.95 g), but the difference between them has decreased significantly to 34.66 g lighter birds and 9.44 g for birds of intermediate weight.

In the first and second period the heavy birds had higher feed intake (58.50 g) when compared to other ($p < 0.05$) (Table 3). In the second period, the consumption between birds with intermediate weight (69.20 g) and heavy birds (75.06 g) did not differ ($p > 0.05$). In the last period, from 42 to 49 days, the treatments did not differ statistically between themselves.

Table 3. Weight gain, feed intake and feed conversion in broilers in the period of 28 to 35, 35 to 42 and 42 to 49 days of age, on the basis of different weights.

Period	Treatments			
	Light	Intermediary	Heavy	CV (%)
Weight gain (g)				
28 – 35 days	102.40^{c}	142.29^{b}	185.45^{a}	10.15
35 – 42 days	179.48^{c}	229.59^{b}	273.65^{a}	8.74
42 – 49 days	243.56^{b}	258.23^{b}	291.95^{a}	8.61
Feed intake bird.day^{-1} (g)				
28 – 35 days	33.02^{c}	45.85^{b}	58.50^{a}	10.82
35 – 42 days	48.81^{b}	69.20^{a}	75.06^{a}	15.38
42 – 49 days	66.13^{b}	75.51^{ab}	90.20^{a}	15.96
Feed Conversion				
28 – 35 days	2.26^{a}	2.27^{a}	2.22^{a}	10.95
35 – 42 days	1.91^{a}	2.11^{a}	1.92^{a}	11.93
42 – 49 days	1.89^{a}	2.05^{a}	2.17^{a}	16.04

* The medium followed by the same letter in the same line do not differ statistically among themselves by SNK to the 5% level of probability; ** Treatment 1: light birds: 150.73 ± 12.62 g; Treatment 2: birds with intermediate weight: 239.79 ± 13.14 g; Treatment 3: heavy birds: 329.17 ± 24.89 g.

To evaluate the data, it was found that heavy birds after a period of constraint, feature better feed efficiency when compared to the other, as they have obtained greater feed consumption and consequently greater gain in weight with feed conversion ratios equivalent intermediate and light birds.

It was observed that the relative gain (Table 4) lightweight animals was significantly higher (p = 0.8002) compared to other treatments in three periods examined.

Table 4. Gain relative, relative weight, uniformity and viability in broilers in the period of 28 to 35, 35 to 42 and 42 to 49 days of age, on the basis of different weights.

Period	Treatments			
	Light	Intermediary	Heavy	CV (%)
Relative gain (%)				
28 – 35 days	168^{a}	159^{b}	156^{b}	3.63
35 – 42 days	288^{a}	255^{b}	240^{c}	4.91
42 – 49 days	450^{a}	363^{b}	329^{c}	5.96
Relative weight (%)				
28 – 35 days	28.38^{c}	42.83^{b}	58.63^{a}	6.44
35 – 42 days	38.32^{c}	54.18^{b}	69.82^{a}	7.01
42 – 49 days	47.32^{c}	60.88^{b}	72.18^{a}	8.92
Uniformity (%)				
28 – 35 days	18.75^{b}	45.83^{a}	61.31^{a}	46.30
35 – 42 days	25.00^{b}	56.25^{a}	63.39^{a}	41.23
42 – 49 days	35.72^{a}	62.50^{a}	57.14^{a}	39.76
Viability (%)				
28 – 35 days	100^{a}	100^{a}	97.92^{a}	2.97
35 – 42 days	100^{a}	100^{a}	100^{a}	0.00
42 – 49 days	97.92^{a}	100^{a}	100^{a}	2.97

* The medium followed by the same letter in the same line do not differ statistically between themselves by SNK to the 5% level of probability; ** Treatment 1: light birds: 150.73 ± 12.62 g; Treatment 2: birds with intermediate weight: 239.79 ± 13.14 g; Treatment 3: heavy birds: 329.17 ± 24.89 g.

In the first trial period, there were no differences (p > 0.05) between the heavy birds and with intermediate weight. Thus, it was evidenced that the 49 days the birds take proportional growth of 4.5 times its initial size, with a gain in weight approximately 3.5 times greater than the heavy birds, consuming only 2.18 g to over feed.

Despite having a higher relative weight gain in light birds, it was observed that the relative weight of heavy birds was higher (P < 0.05) when compared to the other in three periods examined, with 58,63, 69,82 and 72,18%, at 35, 42 and 49 days, respectively.

The birds had 239.90 ± 76.80 g at the beginning of the trial period and at the end had 875.42 ± 177.98 g, thus achieving an average gain of 635.53 g. These were with 63.43% of weight below the recommended by the commercial stage and, with just 21 days receiving rations with higher nutrient content, these have come to possess 38.74% weight lower than required at the end of the experiment, which resulted in a compensatory gain of 25.69% weight.

Discussion

From the sixth week, the temperature for the birds is 20°C and 60 to 70% and relative humidity of air (Abreu & Abreu, 2011). Faria, Campos, Torres, Vieira, Rosa, Vaz, Macaria & Furlan (2007), after surveys concluded that birds exposed to high temperatures have their performance degraded and this is not associated with changes in the metabolism of nutrients from the food rations, but the low feed consumption and the direct effect of room temperature on the bird, due to need of losing heat.

The effect of the restriction on the final body weight is variable as well as the feed conversion. With compensatory gain, an improvement in feed conversion rates is expected (Butzen *et al.*, 2013). However, in this study the feed conversion of batch showed significant difference (p > 0.05) among treatments evaluated 28 to 49 days. Zhan, Wang, Ren, Zhao, Li & Tan, (2007), also showed no difference in relation to the feed conversion, analyzing the effect of early food restriction in metabolic programming and compensatory growth in broiler.

In this experiment the birds did not make the expected average weight and the end of the trial period only 28.87% of the squad was above 1000 g. However, there was a significant improvement in the uniformity of the lot in different periods, 10.72% for birds with light in the final period and 10.42% for birds with intermediate weight to 42 days of age. Heavy birds showed no improvement in uniformity in different periods, taking a turn

for the worse in the last period reviewed. There was no statistical difference ($p > 0.05$) among treatments to 49 days.

Lots more uniforms provide better use for animals, because they have less competition, either for territory or food (Abbas, Gasm & Ahmed, 2010), which leads to a lower energy expenditure with disputes and decreasing in maintenance requirements.

Khetani, Nkukwana, Chimonyo & Muchenje (2009), by applying time restrictions, after the 21 days of age, also didn't check compensatory gain in birds. Contrasting results were found for Butzen *et al*. (2013), where birds of Cobb 500 lineage subject to food restriction by quantity and time have reached the desired end, showing that weight and duration and the application of the age restrictions were appropriate. In this way, the time of application, as well as the intensity and the nutritional quality of the diet may interact to achieve the desired result.

According to Vieira & Moran (1999), the compensatory gain in birds that have suffered prolonged fasting post-hatch can be reduced or even absent. A delay of just 24 hours in consumption can affect growth in a negative way resulting in a decrease of body weight to 49 days of age. Thus, the restriction took place made it impossible that these birds could regain his weight, that is, there wasn't compensation.

Given these concerns, we can affirm that this study has shown that birds exposed to a severe restriction in the first weeks of life, had achieved a committed performance, and may not present a compensatory growth for their age. Therefore, it is extremely important to pay attention if the severity of the restriction, the age of the animals, duration and quality of food provided in feedback.

Conclusion

The broilers had achieved a gain of 25.69% compensatory with a gain in average weight of 635.53 g, however, is believed to be an outcome of expected weight gain to 49 days of age.

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