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Digestible lysine for broiler chickens with lower genetic potential grown on free-range system

Lisina digestivel para frangos de corte de menor potencial genético para crescimento criados em sistema semiconfinado

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ABSTRACT

Determining the actual lysine requirement is crucial as it is an essential amino acid and plays animportant role in the metabolism of broilers. In addition, it is the second limiting amino acid for broilers fed with rations formulated basedon corn and soybean meal. The aim of this study was to determine the digestible lysine requirement for male broilers with lower genetic potential for growth in a semi-confined system as well as to evaluate the effects of different values of digestible lysine on performance and carcass characteristics. A total of 300 broiler chickensfrom a commercial lineage EMBRAPA 041 were used with an average initial weight of 987 g. The broilers were distributed into 20 experimental units in a completely randomized design with five treatments (0.586; 0.746; 0.906; 1.066, and 1.226% digestible lysine), four replicates and 15 broilers per experimental unit.In both periods, there were linear effect of digestible lysine values on the lysine intake and lysine utilization efficiency and quadratic effect on final body weight, weight gain and feed: gain ratio.There was a quadratic effect on the absolute weight of carcasses, breast, thigh + drumstick and income gizzard.For rearing of male broilers with lesser genetic growth potential reared in semi-confinement, rations with 1.040% and 1.103% digestible lysine can be recommended for maximum weight gain in periods from 35 to 70 and 35 to 84 days of age, respectively.

Index terms: Amino acids; nutritional requirements; performance; yield.

RESUMO

A determinação da real exigência de lisina é fundamental, por ser um aminoácido essencial e desempenhar importantes funções no metabolismo dos frangos de corte. Além disto, apresenta-se como segundo aminoácido limitante para frangos de corte alimentados com rações formuladas a base de milho e farelo de soja. O objetivo deste estudo foi determinar a exigência de lisina digestível para frangos de corte machos de menor potencial genético para crescimento em sistema semiconfinado, bem como avaliar os efeitos de diferentes valores de lisina digestível sobre o desempenho e características de carcaça. Foram utilizados 300 frangos de corte, da linhagem comercial EMBRAPA 041, com pesoinicial médio de 987 g. Os frangos foram distribuídos em 20 unidades experimentais em um delineamento inteiramente casualizado, com cinco tratamentos (0,586; 0,746; 0,906; 1,066 e 1,226% de lisina digestível), quatro repetições e quinze frangos por unidade experimental. Nos dois períodos avaliados, verificaram-se efeito linear dos níveis de lisina digestível sobre a ingestão e eficiência na utilização de lisina, e efeito quadrático sobre peso vivo final, ganho de peso e a conversão alimentar. Verificou-se efeito quadrático sobre os pesos absolutos da carcaça, peito, coxa+sobrecoxa e rendimento da moela. Podem ser recomendadas, respectivamente, para máximo ganho de peso rações com 1,040% e 1,103% de lisina digestível nos períodos de 35 aos 70 e 35 aos 84 dias de idade.

Termos para indexação: Aminoácidos; exigência nutricional; desempenho; rendimento.

INTRODUCTION

Lysine is an amino acid that is directly involved in the development of poultry. It is present in large concentrations in muscle protein (Costa et al., 2001; Lana et al., 2005), and interferes in growth rate, feed conversion and amount and quality of meat in the carcass, improving cut yields (Bertechini, 2012). Therefore, lysine-poor diets can compromise productive results (Oliveira et al., 2013).

Determining the actual lysine requirement is crucital, as it is an essential amino acid and plays important roles in the metabolism of broilers. In addition, it is the second limiting amino acid for broilers fed with rations formulated on the basis of corn and soybean meal (Waldroup; Jiang and Fritts, 2005; Faridi et al., 2013).

When evaluating the digestible lysine requirement for conventional chickens, several authors have identified that adequate values provide greater weight gain and better feed conversion (Goulart et al., 2008; Cella, Murakami; Franco 2009; Hease et al., 2012), higher carcass yield, higher breast yield (Amarante Junior et al., 2005), and lower abdominal fat deposition (Trindade Neto et al., 2009). When studying different values of digestible lysine in feed rations for slow growth chickens ISA Label, Nascimento et al. (2009) identified higher weight gain, better feed conversion and lower abdominal fat deposition, while Rosa et al. (2014) did not identify significant differences for feed conversion; however, they identified an increase in weight gain and greater weight of the carcass and breast.

There is scarce information in the literature about specific nutritional requirements for broiler chickens with less genetic potential for growth. In general, feed rations are formulated based on data established for improved broilers with high genetic potential, which may limit the efficiency of use of rations and compromise final profitability.

The objective of this study was to determine the digestible lysine requirement for male broilers with lower genetic potential for growth in a semi-confined system, as well as to evaluate the effects of different values of digestible lysine on performance and carcass characteristics.

MATERIAL AND METHODS

All procedures performed in the experiments were approved by the Ethics Committee of the Federal Rural University of Rio de Janeiro, according to the number 23083.011133/2014-48 Process.

Initially, 800 male broiler chicks (one day old) from commercial lineage "EMBRAPA 041" were housed. The chicks were vaccinated against Marek's disease and fowlpox in a hatchery, and at ten days of age, they were vaccinated against Newcastle disease, according to recommendations of the breeder. Unlimited access to feed ration and water was provided during the entire rearing period. Nutritional requirements were established in order to meet the minimum recommendations reported by the handbook for rearing of free-range broiler chickens - Embrapa 041 (Figueiredo et al., 2006).

In the experiment were used 300 broiler chickens (average initial weight of 987 g) and obtained two phases of evaluation, 35 to 70 and 35 to 84 days of age. The chickens were distributed into 20 experimental units in a completely randomized design, with five treatments (0.586; 0.746; 0.906; 1.066 and 1.226% digestible lysine), four replicates and 15 broilers per experimental unit. The treatments were obtained by addition of L-lysine HCL (78% purity) to the basal diet, replacing corn starch (Table 1).

The experimental unit was composed of 15 chickens housed in a 1.85 x 2.20 m individual pen, containing woodshaving beddings, a tubular feeder, a drinking fountain and a trough. The pen provided access to two10 x 10 m paddocks separated by a metal screen.

Rotation of the chickens in the paddocks was performed weekly according to the growth conditions of Bermuda grass, Tifton 85 (*Cynodon nlemfuensis* x *C. dactylon*). The chickens had free access to the paddocks during the entire experimental period.

Evaluations were made of feed ration intake, weight gain, feed conversion, lysine intake and lysine utilization efficiency (LUE), absolute weight and yields of carcass, cuts and edible offal in periods of 35 to 70 and 35 to 84 days of age.

The feed conversion of the chickens was calculated by dividing the accumulated feed intake by the weight gain in the period and adjusting the data by weighing feed ration leftovers and dead chickens whenever mortality occurred.

Lysine intake was calculated by multiplying the average feed intake by the level of digestible lysine in the feed ration. Lysine intake efficiency was calculated by dividing the average weight gain by the the average value of lysine intake. At 70 and 84 days of age, broilers were selected for slaughter provided their weight represented the average weight of the experimental unit. There were three broilers per experimental unit in the first treatment (twelve broilers per treatment) and six broilers in the second (twenty-four broilers per treatment).

The broilers were submitted to eight-hour fasting, weighed and slaughtered, bled, scalded at 54 ºC for two minutes, plucked and eviscerated. The carcasses were weighed for evaluation of hot carcass weight; then, they were packed in plastic bags and placed in a cooler for two hours. After that, they were transferred to a cold chamber at 10 ºC, where they remained for 24 hours. They were later removed for individual weighing and determination of cold carcass weight.

An evaluation was performed of absolute weights and yields of carcass, breast, wing, thigh+drumsticks, edible offal (gizzard, liver and heart), and abdominal fat.

Carcass yield was calculated on the basis of live weight after fasting and the weight of the cooled, eviscerated, headless and footless carcass. The yields of cuts, organs and edible offal were calculated on the basis of cold carcass weight.

Table 1: Proximate and calculated composition of the basal diet.

Ingredients	Proximate composition
Corn (7.8% PB)[1]	70.885
Soybean meal (45.8% PB)[1]	12.996
Feather meal (87.0% PB)[1]	6.245
Washed sand	5.125
Limestone	1.378
Dicalcium phosphate	1.669
Salt	0.396
Corn starch	0.900
DL-methionine	0.136
Mineral mix[2]	0.120
Vitamin mix[3]	0.110
Coline chlorate	0.040
Total (kg)	100.00
	Calculated composition
Metabolizable energy (kcal/Kg)	2,900
Crude protein	17.000
Linoleic acid	1.428
Total arginine	1.057
Digestible lysine	0.586
Total lysine	0.680
Digestible Methionine + cystine	0.681
Total Methionine + cystine	0.808
Digestible methionine	0.355
Total methionine	0.380
Digestible threonine	0.573
Total threonine	0.699
Total tryptophan	0.142
Digestible tryptophan	0.166
Sodium	0.191
Calcium	1.000
Avaliable phosphorus	0.435

[1/] Value determined from the food safety lab Animal Science Institute of UFFRJ.
[2/] Security levels per kg of product: iron: 60000 mg; copper: 13000 mg; manganese: 120000 mg; zinc: 100000 mg; iodine: 2500 mg; selenium 500 g and excipient q.s.p.:1000 g.
[3/] Security levels per kg of product: Vit. A: 6000000 UI; Vit D_3: 2000000 UI; Vit. E: 1200 mg; Vit K_3: 800 mg; Vit. B_1: 1000 mg; Vit B_2: 4500 mg; Vit B_6: 1500 mg; Vit B_{12}: 12000 mg; niacin: 30000 mg; calciumpantothenate: 10000 mg; folicacid: 550 mg; biotin: 50 g; antioxidant: 5000 mg andexcipientq.s.p.: 1000 g.

The results were submitted to statistical analysis using the software SAEG (System for statistical and genetic analyses) (Universidade Federal de Viçosa - UFV, 2000). The responseswere studied by regression analysis, and digestible lysine requirements were estimated, when possible, through the study of the quadratic model.

RESULTS AND DISCUSSION

Effects of different lysine values on performance

Table 2 shows the effects of different values of lysine on the performance and intake of digestible lysine by male broilers in periods of 35 to 70 and 35 to 84 days of age.

The broilers fed rations with lower lysine values (0.586%) ingested 4663g of ration on average, while the broilers fed rations with the largest value of lysine (1.226%) consumed 5135 g ($\hat{Y} = 4244.3 + 626.87x$; $R^2 = 0.87$). This represents an increase of 472 g.

In comparison, Oliveira et al. (2013), while evaluating digestible lysine values in low-protein diets for free-range broilers, found that an increase in the concentration of digestible lysine in the diet linearly reduced the intake of ration and protein.

By contrast, in the period between 35 to 84 days of age, feed intake was not influenced ($P > 0.05$) by the evaluated values of lysine. The non-significant effect of level of lysine on feed intake in this period is similar with the Rosa et al. (2014) result, who evaluated digestible lysine values for free-range male broilers between 28 to 56 days of age.

As shown by Figures 1 and 2, the largest final live weights for 70 and 84 days of age were estimated from rations containing the values of 1.039% and 1.098% digestible lysine (respectively, of 2631 g and 3212 g). Similarly, when evaluating increasing values of digestible lysine in feeds provided to free-range broilers, Rosa et al. (2014) observed a quadratic effect for final weight, which increased up to the level of 0.909% digestible lysine in the feed ration.

The greatest weight gain for the periods from 35 to 70 (1642 g) and 35 to 84 (2222 g) days of age were estimated by the values of 1.040% and 1.103% digestible lysine in the rations, respectively (Figures 3 and 4). Nascimento et al. (2009) tested increasing values of digestible lysine for free-range broilers, in the period from 28 to 56 days and the best response to weight gain was found with the estimated level of 1.056%. In comparison, Rosa et al. (2014) determined 0.908% of digestible lysine in rations for greater weight gain of free-range broilers in this same phase.

Table 2: Performance and intake of digestible lysine by male broilers between 35 to 70 and 35 to 84 days of age.

Variables	Values of digestible lysine (%)					Reg.[2]	Req.[3]	CV (%)
	0.586	0.746	0.906	1.066	1.226			
35 a 70 days of age								
Feed intake (g)	4663	4825	4848	4886	5135	L	-	2.47
Final body weight (g)	2370	2571	2597	2607	2604	Q	1.039	3.37
Body weight gain (g)	1387	1587	1602	1622	1615	Q	1.040	4.91
Feed: gain ratio	3.37	3.04	3.03	3.01	3.18	Q	0.952	3.66
Intake of lysine(g)	31.71	40.53	48.48	56.68	67.78	L	-	2.28
LUE[1]	43.76	39.13	33.07	28.61	23.84	L	-	4.99
35 a 84 days of age								
Feed intake (g)	7273	7161	7151	7435	7500	NS	-	3.62
Final body weight (g)	2944	3137	3127	3231	3194	Q	1.098	2.70
Body weight gain (g)	1962	2153	2132	2246	2205	Q	1.103	3.58
Feed: gain ratio	3.71	3.33	3.36	3.31	3.41	Q	0.985	3.66
Intake of lysine(g)	49.46	60.15	71.51	86.25	99.00	L	-	3.44
LUE[1]	39.69	35.79	29.84	26.04	22.29	L	-	3.45

NS = not significant; L = linear effect (P < 0,05); Q = quadratic effect (P < 0,05)
[1]LUE = lysine utilization efficiency; [2]Reg. = regression; [3]Req. = requirement (%);

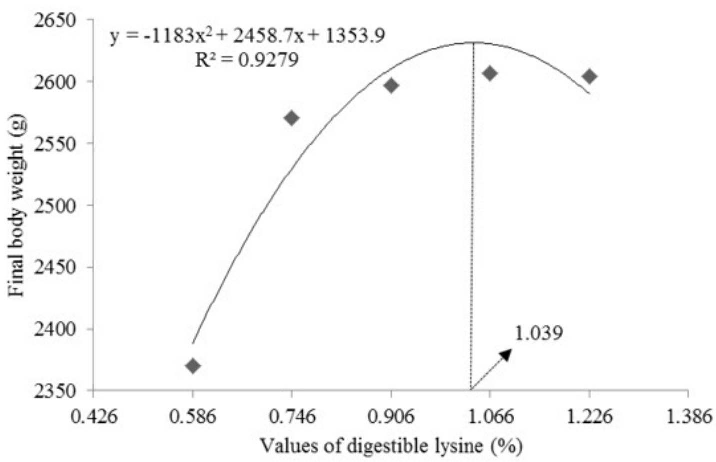

Figure 1: Effect of digestible lysine values on final body weight of broiler chickens in the period from 35 to 70 days of age.

The best feed conversion for the period from 35 to 70 (2.98) and 35 to 84 (3.28) days of age was found, respectively, for rations containing values of 0.952% and 0.985% digestible lysine, respectively (Figures 5 and 6). Goulart et al. (2008), in an experiment to estimate the nutritional requirements of digestible lysine for male broilers, observed a quadratic effect for feed conversion in periods of 1 to 21 and 22 to 42 days of age; the results were found in the values of 1.239% and 0.987% digestible lysine in rations, respectively.

Comparing the evaluation periods chickens showed the period from 35 to 84 days a poorer feed conversion. This can be explained by chickens of higher residence time in the system, a large amount of food intake and deposition ability to lower muscle protein.

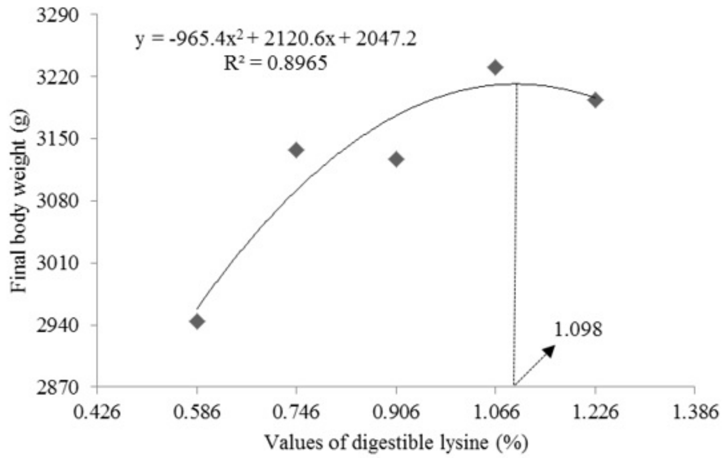

Figure 2: Effect of digestible lysine values on final body weight of broiler chickens in the period from 35 to 84 days of age.

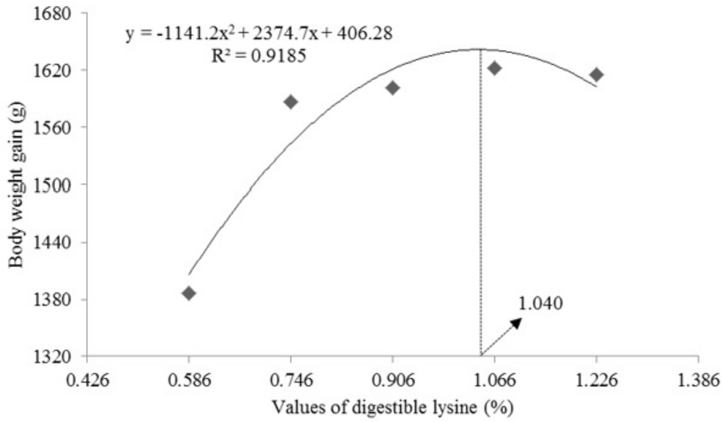

Figure 3: Effect of digestible lysine values on body weight gain of broiler chickens in the period from 35 to 70 days of age.

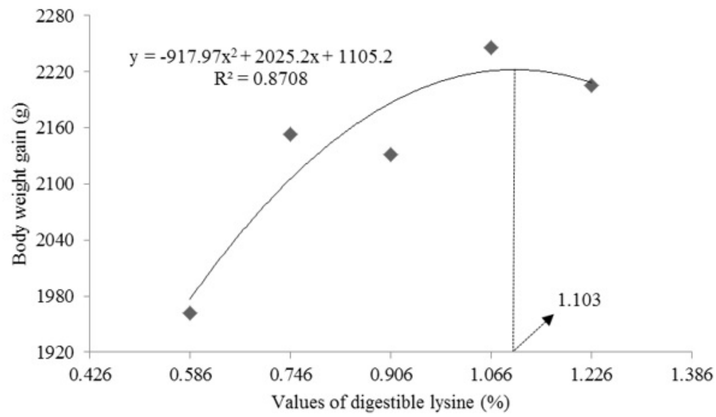

Figure 4: Effect of digestible lysine values on body weight gain of broiler chickens in the period from 35 to 84 days of age.

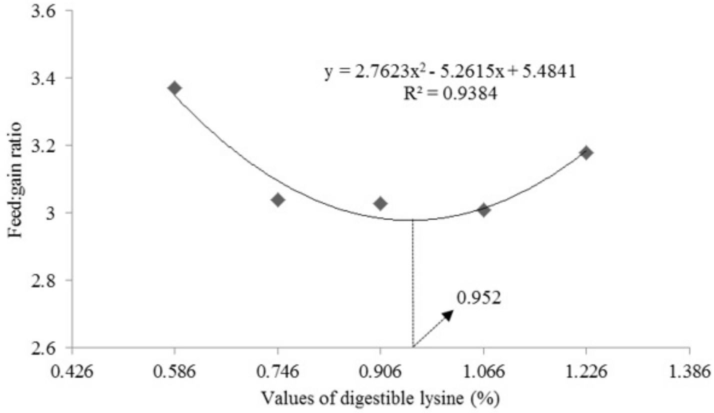

Figure 5: Effect of digestible lysine values on feed:gain ratioof broiler chickens in the period from 35 to 70 days of age.

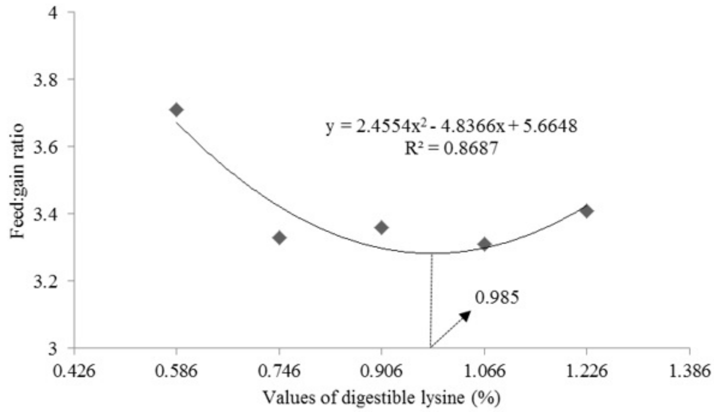

Figure 6: Effect of digestible lysine values on feed:gain ratioof broiler chickens in the period from 35 to 84 days of age.

Nascimento (2003) reported that better feed conversions might be justified by the greater intake of lysine, which provides greater muscular growth, greater weight gain, and reduction of body fat. This effect was confirmed in the present study. Based on the increased values of digestible lysine in rations, there were better feed conversion values.

These results are in agreement with the findings of Leclercq (1998), who reported that as lysine deficiency decreases, there is an improvement in the rates of growth and feed conversion; also, the effect of lysine on body composition may lead to a better feed conversion ratio, since the gain of fat is reduced by high values of lysine.

A linear increase was found in the ingestion of lysine from 35 to 70 and 35 to 84 days of age ($\hat{Y}$ = -6.1452 + 55.181x; R^2 = 1.00 / $\hat{Y}$ = 4.9635 + 78.237x; R^2= 1.00, respectively), and there was a linear reduction in lysine utilization efficiency ($\hat{Y}$ = 65.157- 31.475x; R^2 = 1.00 / $\hat{Y}$= 58.574 - 27.844x; R^2 = 0.99, respectively). These results corroborate those found by Barbosa et al. (2002), who identified a reduction in lysine utilization efficiency, and the findings of Nascimento et al. (2009), who verified an increase in digestible lysine intake as a function of increased values of lysine in feed rations.

The feed intake by chickens did not vary throughthe use of growing values of lysine in the period of 35 to 84 days, which partially explain the increase in lysine intake because of the treatments.On the other hand, although the chickens have responded to the increase in the level of lysine in rations with the greatest rates of weight gain, that did not happen proportionally, what may have led to a worsening in lysine utilization efficiency. Both deficiency and excess of amino acids, particularly lysine in this case, may impair the performance of the chickens. The body weight of poultry rises as the level of lysine rises in the diet, until an optimum level is achieved; after that, there is a reduction in body weight (Ishibashi and Yonemochi, 2002).

Effects of different lysine values on carcass characteristics

In chickens slaughtered at 70 days of age (Table 3) was verified quadratic effect on the absolute weights of carcass, main commercial cuts: breast ($\hat{Y}$ = - 422.96x^2+ 966.4x - 54.76; R^2= 0.98), thigh + drumstick ($\hat{Y}$ = - 393.83x^2+ 895.06x + 87.371; R^2 = 0.99), wing ($\hat{Y}$ = - 122.32x^2+ 295.99x + 58.125; R^2 = 0.99) and abdominal fat ($\hat{Y}$ = 47,405x^2 - 87,979x + 90,286; R^2 = 0.94). But in yield, there was no significant effect on carcass and only the breast ($\hat{Y}$ = - 9.0876x^2 + 19.633x + 18.129; R^2 = 0.80), back ($\hat{Y}$ = 10.555x^2– 21.727x + 34.363; R^2 = 0.75), gizzard ($\hat{Y}$ = 1.8415x^2 – 4.3743x + 5.1343; R^2 = 0.67) and abdominal fat ($\hat{Y}$ = 5,2455x^2 - 10,392x + 8,0092; R^2 = 0.93) obtained quadratic effect. Lana et al. (2005) studied variations on the values in lysine in the ration of 0.88% to 1.12% for male broilers from 22 to 42 days of age also found no variation in carcass yield.

Regarding chickens slaughtered at 84 days of age (Table 4) was observed quadratic effect on the absolute weight ($\hat{Y}$ = - 890.07x^2+ 2049.5x + 1026.7; R^2 = 0.88) and carcass yield ($\hat{Y}$ = - 10,675x^2 + 22,44x + 59,599; R^2 = 0.97), with lysine values estimated at 1.057 and 0.957%. The effect observed in this study for carcass yield is according with those obtained by Nascimento et. al. (2009) working with free-range broiler chickens, with better income estimated in the amount of 0.835% digestible lysine in the ration. The average yield carcass in this study in both slaughter (70 days = 68.61% and 84 days = 70.82%) were higher than those reported by Madeira et al. (2010) at 84 days of age to three free-range lineage, Master Griss (67.95%), Label Rouge (68.99%) and Red Heavy (69.82%).

Table 3: Carcass characteristics of male broilers slaughtered at 70 days of age.

Variables	Values of digestible lysine (%)					Reg.[2]	Req.[3]	CV(%)
	0.586	0.746	0.906	1.066	1.226			
				Absolute weight (g)				
Live weight[4]	2254	2489	2558	2583	2593	Q	1.081	7.09
Carcass	1549	1687	1764	1786	1775	Q	1.081	7.26
Breast	403.83	466.92	481.50	498.33	484.50	Q	1.048	8.82
Thigh+Drumsticks	511.67	566.50	586.50	593.56	584.17	Q	1.042	7.73
Wing	202.00	222.67	230.17	236.83	236.00	Q	1.116	5.43
Back	364.67	379.83	402.17	400.00	414.50	L	-	9.29
Heart	10.58	11.25	11.83	12.17	12.33	L	-	9.78
Gizzard	43.50	47.83	40.92	44.83	44.00	NS	-	7.30
Liver	37.50	40.50	42.00	422.50	43.75	L	-	8.72
Abdominal fat	58.33	42.25	55.92	50.58	52.50	Q	0.928	12.41
				Relative weight (%)				
Carcass	68.69	67.76	68.96	69.17	68.46	NS	-	1.89
Breast	27.16	28.57	28.28	28.84	28.19	Q	0.986	4.44
Thigh+Drumsticks	34.54	34.68	34.43	34.31	34.02	NS	-	3.35
Wing	13.69	13.64	13.54	13.73	13.75	NS	-	4.66
Back	24.56	23.23	23.63	23.11	24.12	Q	0.936	4.59
Heart	0.72	0.69	0.69	0.71	0.72	NS	-	9.32
Gizzard	2.95	2.94	2.41	2.61	2.56	Q	0.897	9.76
Liver	2.53	2.48	2.48	2.46	2.55	NS	-	8.68
Abdominal fat	3.95	2.58	3.31	2.94	3.06	Q	0.991	12.72

NS = not significant; L = linear effect (P < 0,05); Q = quadratic effect (P < 0,05).
[1]LUE = lysine utilization efficiency; [2]Reg. = regression; [3]Exig. = requirement (%); [4]Fasting.

The linear increase for breast yield obtained in this study in chickens slaughtered at 84 days of age are in agreement with the results of Costa et al. (2006). However, Takahashi et al. (2006) found no significant differences in free-range chickens slaughtered at 70 and 84 days old, although there was difference in relation to these chickens from Ross lineage that got higher yield.

The increase in absolute carcass weight for chickens reared up to 84 days of age (Table 4), can be directly related to the linear results of breast yield, explained by greater protein deposition. This effect was verified by Trindade Neto et al. (2009), who observed greaterprotein deposition in the carcass as the values of digestible lysine are increased in rations.According to Leclercq (1998), the breast is the muscle tissue that benefits the most from the increased values of lysine, in virtue of the quantity fibers present in this muscle. In addition, the skeletal muscle is the largest body tissue and retains the greater balance of the set of amino acids of broiler carcass, around 7.5% of all the protein of the carcass composed by lysine (Sklan and Noy, 2004).

The results obtained with the slaughtered chickens at 70 days of age show what has been described in the literature as regards the increase in abdominal fat deposition in the carcass of broilers fed rations that are imbalanced in amino acids. This occurred both in the treatments where lysine was limited and in treatments where it was probably excessive. The estimated value of less abdominal fat in this study was estimated at 0.991% digestible lysine in the ration.

Table 4: Carcass characteristics of male broilers slaughtered at 84 days of age.

Variables	Values of digestible lysine (%)					Reg.[2]	Req.[3]	CV(%)
	0.586	0.746	0.906	1.066	1.226			
Absolute weight (g)								
Live weight[4]	2848	3003	3066	3054	3114	L	-	8.22
Carcass	1990	2157	2189	2166	2201	Q	1.057	8.52
Breast	523.33	586.92	592.92	589.92	610.42	Q	1.114	10.19
Thigh+Drumsticks	676.33	713.50	726.83	720.85	717.17	Q	1.005	8.32
Wing	258.08	272.00	277.50	275.42	278.17	L	-	7.79
Back	445.00	480.33	490.08	489.58	490.83	Q	1.050	10.04
Heat	12.87	14.33	14.62	13.46	14.33	Q	0.993	10.13
Gizzard	51.21	51.12	49.25	51.42	50.37	NS	-	9.11
Liver	41.87	44.54	46.58	45.52	48.21	L	-	7.91
Abdominal fat	63.33	64.50	67.04	61.46	68.62	NS	-	16.10
Relative weight (%)								
Carcass	69.85	71.07	71.34	71.14	70.68	Q	0.957	3.25
Breast	27.54	28.58	28.38	28.42	29.11	L	-	4.40
Thigh+Drumsticks	35.59	34.78	34.88	34.77	34.25	L	-	3.41
Wing	13.60	13.28	13.32	13.29	13.29	NS	-	4.74
Back	23.45	23.39	23.48	23.59	23.39	NS	-	5.07
Heat	0.68	0.70	0.70	0.65	0.69	NS	-	10.73
Gizzard	2.71	2.51	2.37	2.49	2.42	Q	1.035	11.45
Liver	2.21	2.19	2.24	2.19	2.31	NS	-	9.46
Abdominal fat	3.35	3.14	3.24	2.97	3.28	NS	-	16.80

NS = not significant; L = linear effect (P < 0,05); Q = quadratic effect (P < 0,05).
[1]LUE = lysine utilization efficiency; [2]Reg. = regression; [3]Req. = requirement (%); [4]Fasting.

TrindadeNeto et al. (2009) observed in their experiment that abdominal fat weight was influenced by lysine values in the ration. They were reduced as the concentration of amino acid of that increased. The authors recommended the level of 1.01% of digestible lysine as the optimum level. Lesson, Caston and Summers (1996) explained that the lack or excess of amino acids cause metabolic imbalances that limit the growth of lean tissue, thus increasing the amount of deposited fat.

According to Velu, Baker and Scott (1971), liver weight is used as an indicator of deficiency of protein and amino acids. Although the absolute weight of the liver have been influenced linerarly by lysine level in the diets in the two analyzed periods, there is no significant difference in yield. The deficiency of lysine had little influence on liver development and the differences between absolute liver weights are related to variations in corporal development as a whole.

CONCLUSION

For rearing of male broilers animals with lesser genetic potential for growth, reared in semi-confinement, rations with 1.040% and 1.103% digestible lysine can be recommended for maximum weight gain in periods from 35 to 70 and 35 to 84 days of age, respectively.

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