Original Articles

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Responses of broiler chickens to the nutrient recommendations of NRC (1994) and the Ross broiler management manual¤

Respuestas de pollos de engorde a la recomendación de nutrientes del NRC (1994) y al manual de manejo Ross

Respostas de frangos de corte à recomendação de nutrientes do NRC (1994) e manual de gestão Ross

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Summary

Background: broiler producers arbitrarily use feeding standards, potentially compromising bird performance and economic efficiency. **Objectives:** to compare two feeding standards (NRC, 1994 vs. Ross 308 strain catalogue) on productive performance, carcass traits, nutrient consumption and digestibility in Ross 308 strain of broiler chickens. **Methods:** a total of 300 one-day old straight-run broilers were assigned to two feeding programs with five replicates and 30 birds in each. Diets were formulated to meet nutrient requirement recommendation by NRC (1994) and fed during 1-21 and 22-42 days of age, while the diet formulated following Ross 308 strain catalogue recommendation was fed in three periods: 1-10, 11-24 and 25-42 days of age. Fecal digestibility of nutrients was determined after feeding diets containing 0.3% Cr_2O_3 as an external marker. At the end of the experimental period, two birds (one male and one female) from each replicate were slaughtered to determine carcass traits. **Results:** within 1-21 d, the Ross recommended diet increased feed intake and improved feed conversion ratio ($p<0.05$). Over the whole experimental period, the performance parameters were not significantly affected by the dietary treatments. Chickens on the Ross 308 recommended diet consumed more total sulfur containing amino acids per Kg of weight gain during the whole experimental period ($p<0.0001$). There were no significant differences between relative weights of carcasses. The experimental diets had similar digestibility coefficient, cost per Kg of weight gain and European efficiency factor. **Conclusion:** NRC (1994) recommended diets are suggested for feeding Ross 308 broiler chickens because of fewer phases of feeding periods and lower workload.

Keywords: *economic efficiency, growth response, nutrients consumption, phase feeding.*

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Resumen

Antecedentes: los productores de pollos de engorde emplean arbitrariamente estándares de alimentación, que pueden tener un impacto en el rendimiento de las aves y en la eficiencia económica. **Objetivo:** comparar dos programas alimenticios (NRC, 1994 vs. el catálogo Ross 308) sobre el crecimiento, características de la canal, el consumo de nutrientes y digestibilidad en pollos de engorde Ross 308. **Métodos:** un total de 300 pollos de engorde de sexo mixto de un día de edad fueron asignados a dos programas alimenticios con cinco repeticiones y 30 aves cada uno. Las dietas fueron formuladas para cumplir con los requerimientos nutricionales recomendados por la NRC (1994) durante un periodo de tiempo de 1-21 y 22-42 días de edad, mientras que la dieta Ross 308 fue suministrada en tres periodos, 1-10, 11-24 y 25-42 días de edad. La digestibilidad fecal de nutrientes se determinó después de la alimentación de las aves con las dietas sugeridas que contenían 0,3% Cr_2O_3 como marcador externo. Al final del periodo experimental, dos aves (un macho y una hembra) fueron sacrificadas para determinar las características de la canal. **Resultados:** durante los d 1-21, la dieta Ross 308 aumentó el consumo de alimento de las aves y mejoró su rata de conversión alimenticia ($p<0,05$). Durante todo el período experimental, ninguno de los parámetros de rendimiento fue influenciado significativamente por los tratamientos dietéticos. Los pollos en la dieta Ross 308 consumen más aminoácidos azufrados totales por Kg de ganancia de peso durante todo el período experimental ($p<0.0001$). No hubo diferencias significativas entre los pesos relativos de las canales. Las dietas experimentales tuvieron coeficientes de digestibilidad, costos por Kg de ganancia de peso y factor de eficiencia europea similares. **Conclusión:** se sugiere la utilización de la dieta NRC (1994) para la alimentación de pollos de engorde debido a un menor número de fases en los periodos de alimentación y a una menor carga de trabajo.

Palabras clave: *alimentación por fases, consumo de nutrientes, eficiencia económica, respuesta de crecimiento.*

Resumo

Antecedentes: produtores de frangos arbitrariamente empregam padrões de alimentação que podem ter impactos sobre o desempenho das aves e a eficiência econômica. **Objetivos:** para comparar dois padrões de alimentação (NRC (1994) vs. catálogo Ross 308) no desempenho de crescimento, características da carcaça, consumo e digestibilidade dos nutrientes de frangos de corte da linhagem Ross 308. **Métodos:** um conjunto de 300 pintos de sexo misto, com um dia de idade, foram divididos em dois programas de alimentação padrão, com cinco repetições e 30 aves cada. As dietas formuladas pelo NRC (1994) foram fornecidas entre os dias 1-21, e entre os dias 22-42, enquanto as dietas recomendadas por Ross 308 foram fornecidas em três períodos distintos, ou seja, entre os dias 1-10, 11-24 e 25-42. A digestibilidade dos nutrientes fecais foi determinada após o fornecimento de dietas contendo 0,3% Cr_2O_3 como marcador externo. No final do período experimental, duas aves (um macho e uma fêmea) de cada repetição foram abatidas para determinar as características das carcaças. **Resultados:** quando fornecida entre os dias 1-21, a dieta recomendada por Ross aumentou o consumo da ração das aves e melhorou a sua taxa de conversão alimentar ($p<0,05$). Durante todo o período experimental, nenhum dos parâmetros de desempenho foi influenciado significativamente pelos tratamentos dietéticos. As galinhas na dieta recomendada por Ross consumiram mais aminoácidos sulfurados totais por Kg de ganho de peso quando a dieta foi fornecida durante todo o período experimental ($p<0.0001$). Não houve diferenças significativas entre os pesos relativos das carcaças. As dietas experimentais tiveram um semelhante coeficiente de digestibilidade, custo por Kg de ganho de peso e fator de eficiência europeu. **Conclusão:** sugere-se alimentar frangos Ross 308 com dietas recomendadas por NRC (1994) devidos às fases reduzidas dos períodos de alimentação e menor carga laboral.

Palavras chave: *alimentação fase, consumo de nutrientes, eficiência econômica, resposta de crescimento.*

Introduction

To turn poultry farming into a more profitable business, producers use strains with high genetic potential, favorable diet nutrient density, and phase feeding regimes. It is well known that nutrient requirements change as broilers grow. Thus, feeding a single diet during the entire productive period may not satisfy bird requirements, thus it is necessary to use various feeding regimes (Belyavin, 1999; Mehmood *et al*., 2014).

In Iran, most broiler producers are interested in rearing the Ross 308 strain, and they arbitrarily

follow the National Research Council (NRC, 1994) or the Ross 308 catalogue (Anonymous, 2007) recommendations to formulate the diets. Over a period of six weeks they normally apply two or three phase feeding programs when they use NRC (1994) and Ross 308 catalogue, respectively. Phase feeding is described as an economically feasible program in which diets are frequently changed to meet nutritional requirements at different ages (Emmert and Baker, 1997). There are other benefits of phase feeding such as lowering nitrogen excretion to the environment (Pope *et al*., 2004) and the possibility of producing under hot environments (Pope and Emmert, 2002).

According to some studies, feeding programs that include more phases can lead to better final body weight of broiler chickens (Mehmood *et al*., 2014; Hauschild *et al*., 2015). However, no effect of phase feeding on meat quality of birds has been reported (Brewer *et al*., 2012). Dozier *et al*. (2006) did not observe any significant differences in growth response and meat yield of broilers with a three-phase or a four-phase feeding program with high or moderate nutrient density. Improvement in growth performance of broilers has been reported with increased dietary apparent metabolizable energy (AME) and amino acids (Basurco *et al*., 2015), especially lysine (Lys) and sulfur-containing amino acids (SAAs; Kidd *et al*., 1998; 2004; Corzo *et al*., 2005). Warren and Emmert (2000) did not show any improvement in broiler performance when they divided the starter and finisher periods of NRC (1994) into three periods. It has also been determined that if broilers are fed a NRC (1994) starter diet for 30 d and a finisher diet for 18 d in a 48 d raising period they will have the best productive performance and carcass traits (Roush *et al*., 2004). However, few studies have compared different feeding standards. Yan *et al*. (2010) used four feeding standards with different nutrient recommendations, observing remarkable differences in broiler performance. On the other hand, such findings were not obtained by Trevisan *et al*. (2014) who used five different feeding standards. Thus, this study was conducted to compare the effect of NRC (1994) vs. Ross 308 strain feeding standards on growth responses, carcass traits, nutrient digestibility and economic efficiency of Ross 308 strain broiler chickens.

Materials and methods

Birds and diets

A total of 300 one-day old straight-run Ross 308 strain broiler chicks were used. The chicks were distributed into 10 deep-litter floor pens with equal group weight, and were randomly assigned to one of two dietary treatments with five replicates of 30 birds in each. The iso-energetic experimental diets were formulated according to the National Research Council (NRC, 1994) or Ross 308 strain catalogue (Anonymous, 2007) recommendations, and were fed to chickens in two (1-21 and 22-42 days of age) or three (1-10, 11-24, and 25-42 days of age) feeding periods, respectively. The chemical composition of the corn-soybean meal based diets are shown in Tables 1 and 2. The trial was conducted in an environmentally-controlled room. Feed and water were provided *ad libitum* except at weighing times, when feed was withdrawn for 4 h to ensure the emptiness of digestive system contents (Friesen *et al*., 1992). Feed consumption and weight gain were measured at the end of each feeding period and feed conversion ratio was calculated. Mortality of birds in each pen was also recorded daily. Light was provided for 23 h/day, while temperature was gradually reduced from the initial 29 °C to approximately 21 °C by day 21, and was kept constant until the end of the growing period.

Nutrient digestibility and apparent metabolizable energy (AME) determination

To measure digestibility of nutrients and AME of diets, two birds from each replicate (one male and one female) were placed in battery cages. After a one week adaptation period they were fed 0.3% chromic oxide as an indigestible marker in the diets from 40 to 42 days of age. Excreta samples were collected twice per day for three consecutive days and were frozen at -20 °C for subsequent analyses. Excreta samples were oven dried (60 °C, 72 h) and ground prior to analysis. Gross energy of milled feed and excreta samples was measured in an adiabatic calorimeter bomb (Parr 1341, Moline, Illinois, USA). Dry matter, organic matter and ether extract were determined using standard procedures of AOAC (2000), and the chromic oxide content of samples was measured according to the method by Fenton and Fenton (1979).

Table 1. Composition of experimental diets according to NRC (1994) recommendations.

Ingredient (% of diet)	Starter	Grower
Corn	56.80	64.76
Soybean meal (CP 44%)	35.40	27.85
Fish meal	1.00	1.00
Soybean oil	2.31	1.39
Oyster shell	1.34	1.84
Dicalcium phosphate	1.53	1.66
Common salt	0.396	0.326
Vitamin premix[1]	0.5	0.5
Mineral premix[2]	0.5	0.5
DL-Methionine	0.151	0.055
L-Lysine HCl	0.073	0.119
Total	100	100
Nutrient composition		
AMEn (Kcal/Kg)	2950	2960
Crude protein (%)	21.203	18.499
Arg (%)	1.365	1.157
Lys (%)	1.208	1.052
Met (%)	0.490	0.360
Met+Cys (%)	0.832	0.666
Ca (%)	0.997	1.200
Available P (%)	0.453	0.467
Na (%)	0.180	0.150

[1]Supplied per Kg of diet: vitamin A, 18,000 IU; vitamin D_3, 4,000 IU; vitamin E, 36 mg; vitamin K_3, 4 mg; thiamin, 3.5 mg; riboflavin, 13.2 mg; calcium pantothenate, 19.6 mg; niacin, 59.4 mg; pyridoxine, 5.88 mg; folic acid, 2 mg; vitamin B_{12}, 0.03 mg; biotin, 0.2 mg; coline chloride, 500 mg; antioxidant, 2 mg;

[2]Supplied per Kg of diet: Mn, 198.4 mg; Zn, 169.4 mg; Fe, 100 mg; Cu, 20 mg; I, 1.98 mg; Se, 0.4 mg.

Table 2. Composition of experimental diets according to Ross 308 strain recommendations.

Ingredient (% of diet)	Starter	Grower	Finisher
Corn	54.84	60.00	65.90
Soybean meal (CP 44%)	33.39	31.80	27.33
Fish meal	5.45	2.00	1.00
Soybean oil	2.18	1.70	1.09
Oyster shell	1.19	1.19	1.19
Dicalcium phosphate	1.17	1.71	1.84
Common salt	0.330	0.310	0.406
Vitamin premix[1]	0.5	0.5	0.5
Mineral premix[2]	0.5	0.5	0.5
DL-Methionine	0.282	0.225	0.196
L-Lysine HCl	0.168	0.065	0.048
Total	100	100	100
Nutrient composition			
AMEn (Kcal/Kg)	2950	2950	2960
Crude protein (%)	23.174	20.486	18.385
Arg (%)	1.464	1.300	1.145
Lys (%)	1.450	1.150	0.990
Met (%)	0.688	0.561	0.495
Met+cys (%)	1.043	0.890	0.800
Ca (%)	1.023	1.024	1.000
Available P (%)	0.487	0.512	0.5
Na (%)	0.180	0.150	0.180

[1]Supplied per Kg of diet: vitamin A, 18,000 IU; vitamin D_3, 4,000 IU; vitamin E, 36 mg; vitamin K_3, 4 mg; thiamin, 3.5 mg; riboflavin, 13.2 mg; calcium pantothenate, 19.6 mg; niacin, 59.4 mg; pyridoxine, 5.88 mg; folic acid, 2 mg; vitamin B_{12}, 0.03 mg; biotin, 0.2 mg; coline chloride, 500 mg; antioxidant, 2 mg;

[2]Supplied per Kg of diet: Mn, 198.4 mg; Zn, 169.4 mg; Fe, 100 mg; Cu, 20 mg; I, 1.98 mg; Se, 0.4 mg.

AME of the diets was determined according to Sibbald and Slinger (1963), and apparent digestibility (AD) of nutrients was measured according to Saha and Gilbreath (1993) using the following equations:

$$\text{AME}\left(\frac{\text{Kcal}}{\text{Kg}}\right) = \text{diet gross energy} \times \left\{1 - \left(\left(\frac{\%\ \text{diet}\ Cr_2O_3}{\%\ \text{excreta}\ Cr_2O_3}\right) \times \left(\frac{\text{excreta gross energy}}{\text{diet gross energy}}\right)\right)\right\} \quad (1)$$

$$\text{AD}\ (\%) = \left\{1 - \left[\left(\frac{\%\ \text{diet}\ Cr_2O_3}{\%\ \text{excreta}\ Cr_2O_3}\right) \times \left(\frac{\%\ \text{excreta nutrient}}{\%\ \text{diet nutrient}}\right)\right]\right\} \times 100 \quad (2)$$

Carcass traits

At 42 days of age, two birds (one male and one female) from each pen (replicate) were selected,

weighed and killed by decapitation. Birds were immediately dissected and eviscerated, then edible parts of the carcass including breast and thighs and digestive enclosed glands including liver and pancreas as well as abdominal fat were weighed.

Nutrient consumption and economic evaluation

Apparent metabolizable energy corrected to zero nitrogen (AMEn), crude protein, lysine and

$$EEF = \left[\frac{(\text{live weight (Kg)} \times \text{survivability (\%)})}{(\text{feed conversion ratio} \times \text{age (day)})}\right] \times 100 \quad (3)$$

SAAs consumption per each Kg of live weight gain were calculated to evaluate the efficiency of dietary treatments. Survivability percent and feed cost per Kg of live weight gain were determined, and European efficiency factor (EEF) was calculated using the following equation:

Statistical analysis

Data were subjected to statistical analysis using the t-test procedure of SAS® (SAS Institute, 2002) (Statistical Analysis System Institute, Cary, NC, USA). The significant differences between mean values was also examined by t-test ($p<0.05$). Percentage values were transformed to arcsine $\sqrt{n}$ before statistical analysis.

Results

According to the data presented in Table 3, the Ross 308 strain recommended diet improved weight gain (WG) and feed conversion ratio (FCR) form 1 to 10 days of age without significant effect on feed intake (FI; $p<0.001$). The reason to report data in this period is feeding each group of chickens with their own starter diets. However, to compare the effect of feeding standards on growth response, data were reported according to NRC (1994) feeding periods (1-21 and 22-42 days of age). During the starter period, birds fed the Ross 308 diet consumed more feed and had higher feed conversion ratio compared with those on the NRC 308 diet ($p<0.05$). Dietary treatments did not significantly affect WG. Through the grower period (22-42 days of age) and also the entire experimental periods, none of the growth parameters were affected by treatments, although WG of birds on Ross 308 diets tended to be significantly higher ($p = 0.0627$).

Table 3. The effect of NRC (1994) and Ross 308 strain feeding standards on growth performance of Ross 308 strain broiler chickens.

	NRC (1994)	Ross 308 strain	t<probability
1 to 10 d			
Feed intake (g/bird)	173.0	178.2	0.2992
Weight gain (g/bird)	100.9^b	118.2^a	0.0009
Feed conversion ratio	1.71^a	1.51^b	0.0002
1 to 21 d			
Feed intake (g/bird)	740.4^b	789.8^a	0.0181
Weight gain (g/bird)	520.0	529.13	0.4842
Feed conversion ratio	1.42^b	1.49^a	0.0292
22 to 42 d			
Feed intake (g/bird)	3201.0	3247.6	0.6601
Weight gain (g/bird)	1550.8	1622.30	0.0550
Feed conversion ratio	2.06	2.00	0.3088
1 to 42 d			
Feed intake (g/bird)	3941.4	4037.4	0.3667
Weight gain (g/bird)	2070.9	2151.5	0.0627
Feed conversion ratio	1.90	1.88	0.5214

^{a,b} Mean values within rows with different superscript letters are significantly different ($p<0.05$).

The amount of AMEn, crude protein, Lys and SAAs consumed per Kg of live weight gain of broilers during different feeding periods showed that birds on the Ross 308 diets had higher energy, crude protein and Lys ($p<0.05$), as well as SAAs ($p<0.0001$) consumption when compared with those on the NRC (1994) diets from 1 to 21 days of age. However, similar results were observed, except for SAAs, from 22 to 42 days of age and also throughout the whole experimental period (Table 4).

As shown in Table 5, at the end of 42 d growing period, the relative weights of dressed carcass, breast and thigh meat as well as abdominal fat and enclosed glands of digestive system (including pancreas and liver) were not affected by the dietary treatments.

Table 4. The effect of NRC (1994) and Ross 308 strain feeding standards on energy and nutrient consumption (per Kg of weight gain) by Ross 308 strain broilers during several experimental periods.

	NRC (1994)	Ross 308 strain	t<probability
1 to 21 d			
AMEn (Kcal/Kg)	4201.9^{b}	4404.7^{a}	0.0231
Crude protein (g/ Kg)	302.0^{b}	314.9^{a}	0.0365
Lysine (g/ Kg)	17.2^{b}	18.2^{a}	0.0106
SAAs† (g/ Kg)	11.8^{b}	13.8^{a}	<0.0001
22 to 42 d			
AMEn (Kcal/ Kg)	6115.6	5917.2	0.2957
Crude protein (g/ Kg)	382.2	379.1	0.7887
Lysine (g/ Kg)	21.7	20.7	0.1249
SAAs (g/ Kg)	13.8b	16.5^{a}	0.0002
1 to 42 d			
AMEn (Kcal/ Kg)	5634.0	5545.6	0.5184
Crude protein (g/ Kg)	362.0	363.4	0.8704
Lysine (g/ Kg)	20.6	20.1	0.2738
SAAs (g/ Kg)	13.3^{b}	15.8^{a}	<0.0001

^{a,b} Mean values with different superscript letters within rows are significantly different (p<0.05).

† Sulfur containing amino acids.

Table 5. The effect of NRC (1994) and Ross 308 strain feeding standard on carcass traits of Ross 308 strain broiler chickens at 42 days of age (% of live body weight).

	NRC (1994)	Ross 308 strain	t<probability
Dressed carcass	60.58	62.48	0.3867
Breast	21.02	21.97	0.2272
Thighs	19.39	19.39	0.9534
Abdominal fat	2.18	1.98	0.0981
Pancreas	0.22	0.24	0.3226
Liver	1.98	2.09	0.3604

Both NRC (1994) and Ross 308 strain recommended diet had similar AME and apparent digestibility of dry matter, organic matter, and ether extract (Table 6). Feeding the dietary treatments to birds during the 42 d growing period also resulted in similar cost of FI per Kg of live BW, survivability rate, and European efficiency factor (Table 7).

Table 6. The effect of NRC (1994) and Ross 308 strain feeding standards on nutrient digestibility and apparent metabolizable energy of Ross 308 strain broiler chickens at 42 days of age.

	NRC (1994)	Ross 308 strain	t<probability
Dry matter (%)	74.42	75.12	0.8827
Organic matter (%)	77.85	78.20	0.9389
Ether extract (%)	56.64	58.41	0.7993
AME (Kcal/Kg)	3001.0	3071.7	0.7533

Table 7. The effect of NRC (1994) and Ross 308 strain feeding standards on some economic indexes of Ross 308 strain broiler chickens at 42days of age.

	NRC (1994)	Ross 308 strain	t<probability
Feed cost/Kg of live BW (IRR[1])	24512	24292	0.7021
Survivability (%)	96.00	94.67	0.6199
European efficiency factor	229.81	244.42	0.4242

[1]1 USD ≈ 30300 IRR.

Discussion

Although in both feeding standards (NRC (1994) and Ross 308 strain catalogue), the requirement for crude protein and amino acids decreased with increasing age, nutrient density recommended by both standards was different, and nutrient density of the diet formulated according to Ross 308 strain catalogue was higher than that of diets formulated according to NRC (1994) recommendations, as shown in Tables 1 and 2. It is evident that broiler growth performance improves when nutrient density of diet increases (Corzo *et al*., 2005; Dozier *et al*., 2006; Brickett *et al*., 2007; Yan *et al*., 2010). Furthermore, it has also been reported that WG and FCR is affected by decreasing crude protein (Bregendahl *et al*., 2002; Si *et al*., 2004; Faria Filho *et al*., 2005; Hernández *et al*., 2013). In most studies, improvement of growth performance due to high protein has been more pronounced in young broilers (Bregendahl *et al*., 2002; Faria Filho *et al*., 2005; Yan *et al*., 2010). In agreement with those studies, in

the current study, WG ($p<0.001$) and FCR ($p<0.001$) improved during 1 to 10 days of age by feeding the Ross 308 diet as well. However, by decreasing dietary crude protein from 23.174 to 20.486% in the grower period of Ross 308 strain (Table 2), such improvement was not observed. Apparently, if that reduction in dietary crude protein did not happen or was less than that, the improvement in growth performance would be followed. But, because of a direct relationship between crude protein intake and nitrogen excretion by broiler chickens (Faria Filho *et al*., 2005; Hernandez *et al*., 2013) this suggestion will be questioned in terms of environmental considerations.

It is well known that broilers consume the diet to meet their need for energy (Pesti and Smith, 1984; Plavnik *et al*., 1997). In this study, as diets were formulated iso-energetically, the probable reason for higher FI and FCR with the Ross 308 diet (during 1-21 days of age) is an inadequate supply of nutrients such as amino acids. A 2.6% decrease in crude protein and similar reduction in amino acid levels when compared with the starter diet of Ross 308 strain may cause such higher feed intake, as birds had to consume more feed to meet the requirements and maintain their growth pattern at the starter period. It has been shown by Lipstein *et al*. (1975) that broiler chickens eat the amount of feed to meet their requirement for protein and/or essential amino acids. Furthermore, in the study by Kidd *et al*. (2004), when amino acid density of broiler diet was lowered from 15 to 28 days of age, FCR was affected, similar to our findings. It is remarkable that chickens on the Ross 308 diet consumed the amount of feed to have the same energy to protein ratio as those on the NRC 308 diet (13.91 Kcal/g vs. 13.98 Kcal/g, respectively; Table 4). No significant difference ($p>0.05$) in growth parameters was observed. Such finding has been reported by Dozier *et al*. (2006), who used three or four feeding phases and did not show any significant differences in final body weight of birds. It has also been shown that using five different feeding standards to feed broilers for 49 days resulted in similar WG, FI and FCR (Trevisan *et al*., 2014).

The higher consumption of energy and nutrients through 21 days by birds on the Ross 308 diet as compared with those on the NRC (1994) diet was due to significantly higher FI in this period (Table 3). Although chickens on the Ross 308 diet had higher SAAs consumption/Kg of live BW for the 22-42 days period and also throughout the experimental period, their growth performance and carcass, breast and thigh meat yields was similar to those fed diets formulated according to NRC (1994) recommendations (Table 5). In agreement with these results, Si *et al*. (2004) did not observe any improvement in growth performance by increasing the SAAs content of the diet.

The finding on abdominal fat was not in agreement with other reports (Kidd *et al*., 2004; Corzo *et al*., 2005), which noted that high amino acid content in the diet induces lower abdominal fat in chickens.

In conclusion, as birds on the NRC (1994) or the Ross 308 catalogue diets had a similar growth response at the end of the feeding trial and since there was no significant difference in economic efficiency between both standards, none of them appeared to have any advantage over the other. However, due to fewer phase feeding of the NRC (1994; 2 vs. 3) and higher SAAs consumption of the Ross 308 diets per Kg of live weight gain, feeding of Ross 308 chickens with the NRC (1994) recommended diets is suggested.

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Conflicts of interest

The authors declare that they have no conflicts of interest with regard to the work presented in this report.

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