DIFFERENT NUTRITIONAL RECOMMENDATIONS FOR BROILERS: PERFORMANCE AND ECONOMIC ANALYSIS[1]

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ABSTRACT: The objective of this research was to compare the effect of different nutritional recommendations on the performance and economics of the production of broiler chickens. A total of 1,200 Cobb-500 line male broilers were placed in a completely randomized design with four treatments and 10 replicates, with 30 animals each. The diets in each treatment were as follows: 1. COBB-VANTRESS (2009); 2. Commercial feed; 3. Rostagno *et al.* (2005); and 4. Rostagno *et al.* (2011). The following performance traits were evaluated: feed intake (FI), weight gain (WG), body weight (BW), feed conversion (FC) and productive efficiency index (PEI). The experiment ran while chickens were 1 to 21 and 1 to 42 days old. For the economic analysis, the diet cost and live weight price were considered when calculating the average cost of the diet (ADC) and the gross trading margin (TM). Analysis of variance was used to evaluate ADC and TM performance traits; diets means were compared with Tukey's test. In the 1 to 21 day period, there was a higher FI and less efficient FC with diet 1 and more efficient PEI with diet 4. During the 1 to 42 day period, diets 1, 3 and 4 had the highest BW, WG and PEI. TM and ADC show similar results, i.e., commercial feed being less attractive to producers. For the entire experimental period, the nutritional recommendations of COBB-VANTRESS (2009), Rostagno *et al.* (2005) and Rostagno *et al.* (2011) had the highest productive and economic performance for broiler production.

Keywords: birds, broiler, cost, crude protein, energy.

DIFERENTES RECOMENDAÇÕES NUTRICIONAIS PARA FRANGOS DE CORTE: DESEMPENHO E ANÁLISE ECONÔMICA

RESUMO: O objetivo deste trabalho foi comparar diferentes recomendações nutricionais sobre o desempenho e análise econômica na produção de frangos de corte. Foram utilizados 1.200 frangos, machos, da linhagem Cobb-500. As aves foram submetidas a delineamento inteiramente casualizado com 4 tratamentos e 10 repetições, com 30 animais cada. As dietas consistiram: 1. COBB-VANTRESS (2009); 2. Ração Comercial; 3. Rostagno *et al.* (2005) e 4. Rostagno *et al.* (2011). As características de desempenho avaliadas foram: consumo de ração (CR), ganho de peso (GP), peso corporal (PC), conversão alimentar (CA) e índice de eficiência produtiva (IEP). Esta avaliação ocorreu no período de 1 a 21 e de 1 a 42 dias de idade dos frangos. Para análise econômica foram considerados o custo da dieta e o preço do frango vivo, visando o cálculo do custo médio da dieta (CMD) e da margem bruta de comercialização (MB). Os resultados de desempenho, CMD e de MB foram analisados por meio da análise de variância. Empregou-se o teste de Tukey (P<0,05) para a comparação entre as médias dos tratamentos. De 1 a 21 dias, verificou-se maior CR e pior CA na dieta 1 e melhor IEP na dieta 4. De 1 a 42 dias verificou-se melhor resultado de PC, GP e IEP nas dietas 1, 3 e 4 em relação à dieta 2. Situação semelhante foi observada para TM e CMD, em que a ração comercial foi menos atrativa aos produtores. Considerando o período total de criação,

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conclui-se que as recomendações nutricionais da COBB-VANTRESS (2009), Rostagno *et al.* (2005) e Rostagno *et al.* (2011) apresentaram melhores resultados de desempenho produtivo e econômico para a produção de frangos de corte.

Palavras-chaves: aves, frango, custo, proteína bruta, energia.

INTRODUCTION

Nutrition is an important aspect of poultry science because a proper diet can improve productivity and carcass yield. The most relevant characteristic in the formulation of chicks' diets is the concentration of protein and energy, which influence both the diet cost and broiler chicken performance (Leandro *et al.*, 2003; Corrêa *et al.*, 2008). Nutrition is the factor with most influence on the production cost in modern poultry science representing on average 60% to 70% of the total cost of production (Brum *et al.*, 1993; Nascimento *et al.*, 2005).

In recent years, progress in genetics, installations, nutrition, management and sanity have transformed national Brazilian poultry science in a complex economic category, in which maximum production of meat with lowest production cost is the objective (Oliveira *et al.*, 2006). Nutritional requirements during feed formulation need to be updated; continuous genetic breeding of the birds can alter the productivity and maintenance of the chick's lines and even the growth speed, which can vary with sex and form of the birds.

The availability of different nutritional recommendations from several Brazilian regions and foreign countries, inconsistent with the climatic and productive reality of Brazil, has also complicated establishing an optimal nutritional recommendation for broiler chickens (Araújo *et al.*, 2002).

The objective of this research was to compare different available nutritional recommendations with respect to their performance and economics in the production of broiler chickens.

MATERIAL AND METHODS

The experiment was carried out at the Experimental Aviary of the Faculdade de Zootecnia e Engenharia de Alimentos da Universidade de São Paulo, located on the administrative campus of Pirassununga, from September, 17, 2011 to October, 22, 2011.

One thousand two hundred Cobb-500® line, day-old male broilers, with a mean weight of 45.86 g were used. Feeding periods were divided as follows: days 1 to 7, pre-start; days 8 to 21, start; days 22 to 35, growth; and days 36 to 42, finish. The commercial feed was divided in the start phase (days 1 to 21) and growth phase (days 22 to 42), following the manufacturer's recommendations.

The experimental diets were as follows: 1. COBB-VANTRESS (2009); 2. Commercial feed; 3. Rostagno *et al.* (2005); and 4. Rostagno *et al.* (2011). The commercial feed is very common in the Brazilian market and broadly used by small poultry producers.

Day-old chicks were sheltered in the experimental aviary inside 40 boxes (2.47 m^2) with 30 birds each. To heat the chicks during the initial phase, incandescent bulbs were used in the boxes and gas brooders in the runways. Continuous light was used throughout the experiment. Temperature and relative humidity were recorded daily using a thermohygrometer. The mean maximum and minimum temperatures registered were 30.29 ± 3.14 and 22.20 ± 2.25°C, respectively. The mean maximum and minimum values for relative humidity were 57.70 ± 17.66% and 32.03 ± 22.17%, respectively.

The following performance traits were evaluated from days 1 to 21 and 1 to 42: feed intake (FI), weight gain (WG), body weight (BW), feed conversion (FC) and productive efficiency index (PEI).

$$PEI = \frac{WGd \times L}{F10 \times C}$$

where WGd is the daily weight gain (g), and L is the livability (100%-%mortality).

The experimental design was completely randomized with 10 replicates per treatment, for a total of 40 plots with 30 individuals each.

Economic efficiency was determined while taking into account prices of the factors (diet cost) and product (live weight). The gross margin trading (TM) was calculated as follows:

$$TM = \frac{TWG_i}{FI_i} \times \frac{BW_i}{DC}$$

where TWGi is the price of the live weight (R$/kg) and DC is the cost of the diet consumed by the chickens during the entire experiment obtained as a function of the composition and price of the ingredients. BWi and FIi were obtained from the 42 day experiment. The product price and feed ingredient prices were obtained from the market, using the Instituto de Economia Agricola, da Secretaria de Agricultura e Abastecimento do Estado de São Paulo database as a reference. The (DC) was the sum of the product of ingredient quantities (IQ) and their prices (IP).

$$DC = \sum IP \times IQ$$

Ingredient quantities (IQ) were defined during feed formulation and are presented in Tables 1 and 2. The cost of diet 2 was based on market price because precise composition was not available on the label.

The average cost of the diet (ADC) was also calculated using DC and feed intake in each experimental phase, following the nutritional recommendations for the period from 1 to 42 days. For diet 2, the price of this feed in August 2011 was used.

To obtain representative historic prices, the monthly prices of these products during five years were used. Nominal prices were corrected by the national index of consumer prices (NIPC) from the Instituto Brasileiro de Geografia e Estatística (IBGE) for August 2011, according to the following formula:

$$PQ_{corrected,t} = PQ_{nominal,t} \times \left(\frac{NIPC_{august,2011}}{NIPC_t}\right)$$

where $PQ_{corrected,\,t}$ is the actual price of the ingredient in month t corrected for August, 2011; $PQ_{nominal,\,t}$ is the price of the ingredient in month t; $NIPC_{august,\,2011}$ is the index for August, 2011; and $NIPC_t$ is the index for month t. The corrected prices are presented in Table 3.

TM calculations used the mean values of the corrected price. ADC and TM were analyzed using an ANOVA in Statistical Analysis System (SAS Inst., Inc., Cary, NC). Tukey's test (P<0.05) was used for the comparison of treatment means.

RESULTS AND DISCUSSION

In the period from 1 to 21 days, BW and WG were different (P<0.05) between the commercial feed and other diets (Table 4). FI differed (P<0.05) between all experimental diets and the highest consumption was found for diet 1. The best results for PEI were obtained using the Rostagno *et al.* (2011) diet (diet 4).

In the period from 1 to 42 days, BW, WG, FI and PEI were different (P< 0.05) between the diets (Table 5). The commercial feed, diet 2, had lower BW, WG, FI and PEI. Experimental diets 3 and 4 yielded the best results for FC.

The nutrient content between the experimental diets varied, mostly in relation to crude protein, amino acids and calcium. The supply of these essential nutrients in broiler chicken diets has an important effect on determining the production of chicken. Vitamins and microminerals are provided to fulfill minimal requirements (Araújo *et al*., 2002).

Except for diet 2, the different diets did not affect WG. Costa *et al.* (2001), who tested the effect of different levels of crude protein in chicks, found similar results. In contrast, Sabino *et al.* (2004) found a linear increase in WG as protein increased in the diets used in their study.

In the period from 1 to 42 days, there were no differences in FI between diets 1, 3 and 4. Similarly, Kolling *et al.* (2005) found no differences in FI with respect to different protein levels during the 1 to 49 day broiler chick age period. This finding was also observed by Sabino *et al.* (2004).

For the COBB-VANTRESS (2009) treatment, FC was lower in the 1 to 21 day period. Chicks that consumed this lower protein diet increased their feed intake. Although this increase was not significant, it affected FI and FC for the total period. This increase may have occurred to fulfill nutritional deficiencies or because individuals with high levels of Ca intake (present in diet 1 when compared to the other diets) had decreased utilization of other nutrients in the diet due to the formation of insoluble calcium complexes (Sá *et al.,* 2004).

The increase in FI did not increase WG, therefore decreasing FC for these individuals in both experimental periods. Vasconcellos (2009) had similar results with 21 day-old chicks, where the reduction in protein decreased FC.

The lack of information about the nutrients used in the commercial feed complicated the interpretation of the results and explanation of the unfavorable performance of this treatment. The quality of the ingredients and manufacturing process may have contributed to this fact.

The ADC and MT as a function of diet treatments are shown in Table 6. Diet 1, COBB-VANTRESS (2009), had the lowest ADC (P < 0.05), whereas diet 2 had the highest.

Table 1. Centesimal nutritional composition of recommended diets

	Feeding phase											
	Days 1 to 7			Days 8 to 21			Days 22 to 35			Days 36 to 42		
Ingredients	Diet 1[1]	Diet 3	Diet 4	Diet 1	Diet 3	Diet 4	Diet 1	Diet 3	Diet 4	Diet 1	Diet 3	Diet 4
Corn	59.953	58.809	57.183	65.061	61.578	59.662	66.759	61.955	62.625	66.759	66.212	66.913
Soybean meal (45%)	34.126	35.694	37.035	28.636	33.167	34.134	26.006	30.705	30.557	26.006	26.640	26.644
Bicalcium phosphate	2.093	1.920	1.913	2.019	1.772	1.554	1.877	1.676	1.329	1.877	1.527	1.107
Limestone	0.838	0.735	0.677	0.826	0.734	0.740	0.777	0.701	0.708	0.777	0.669	0.641
L-lysine HCl	0.123	0.397	0.345	0.172	0.240	0.304	0.202	0.254	0.298	0.202	0.310	0.323
MHA (methionine)	0.265	0.416	0.416	0.259	0.284	0.362	0.276	0.293	0.334	0.276	0.287	0.307
L-Tryptophan	*	*	*	*	*	*	0.002	*	*	*	*	*
L-Threonine	0.099	0.164	0.135	0.124	0.067	0.100	0.142	0.229	0.092	0.142	0.090	0.096
Mineral and Vitamin supplement[2]	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
Salt	0.348	0.346	0.345	0.279	0.324	0.345	0.282	0.341	0.302	0.282	0.301	0.293
Soybean oil	1.642	1.007	1.439	2.112	1.323	2.309	3.165	3.512	3.243	3.165	3.452	3.160
Sodium bicarbonate	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
Choline chloride	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Feed guard	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013	0.013
Inert	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
Nutrients												
Calcium %	1.000	0.940	0.920	0.960	0.880	0.840	0.900	0.837	0.758	0.900	0.775	0.663
Metabolizable Energy (kcal/kg)	2990	2950	2960	3083	3000	3050	3176	3150	3150	3176	3200	3200
Available P %	0.500	0.470	0.470	0.480	0.440	0.400	0.450	0.418	0.354	0.450	0.386	0.309
Lysine digestible %	1.080	1.330	1.320	0.990	1.150	1.220	0.950	1.099	1.131	0.950	1.048	1.060
Methionine digestible %	0.520	0.654	0.660	0.490	0.532	0.601	0.491	0.525	0.560	0.491	0.503	0.521
Methionine and Cystine digestible %	0.800	0.940	0.950	0.750	0.810	0.880	0.740	0.791	0.826	0.740	0.755	0.774
Crude protein %	21.000	22.000	22.400	19.000	20.800	21.200	18.000	19.730	19.800	18.000	18.310	18.400
Sodium %	0.220	0.220	0.220	0.190	0.210	0.210	0.190	0.208	0.200	0.190	0.198	0.195
Threonine digestible %	0.790	0.870	0.860	0.740	0.750	0.790	0.720	0.714	0.735	0.720	0.681	0.689
Tryptophan digestible %	0.233	0.241	0.248	0.203	0.228	0.232	0.190	0.213	0.213	0.190	0.192	0.192

[1]Diet 1, COBB-VANTRESS (2009); Diet 3, ROSTAGNO *et al*. (2005); Diet 4, ROSTAGNO *et al*. (2011). [2]Composition of vitamin and mineral supplementation (kg of product): Vitamin A: 2.204.000.00 IU. Vitamin D3: 550.000.00 IU. Vitamin E: 8250.00 IU. Vitamin K3: 440.00 mg. Vitamin B1: 590.00 mg. Vitamin B2: 1.470.00 mg. Vitamin B6: 823.00 mg. Vitamin B12: 3.500.00 mcg. Niacin: 8.750.00 mg. Pantothenic acid: 3.250.00 mg. Folic Acid: 200.00 mg. Choline: 78.12 g. Iron: 12.50 g. Manganese: 20.00 g. Zinc: 25.00 g. Iodine: 300.00 mg. Selenium: 75.00 mg. BHT: 25.00 g.

Table 2. Assurance levels of commercial feed

	Start (1-21)	Growth (22-42)
Moisture (max)	13.00	13.00
Crude protein (min)	21.00	19.50
Ether extract (min)	2.00	2.00
Fibrous material (max)	5.00	5.50
Ash (max)	8.50	9.00
Calcium (max)	1.70	1.90
Phosphorus (min)	0.35	0.40
Lasalocid	*	0.009
Coccidiostat	0.0125	*

Table 3. Corrected mean prices of ingredients and live weight

Ingredients	Mean Price (R$/kg)	Source
Corn	0.40	IEA – APTA[1]
Soybean meal	0.83	
Soybean oil	3.12	
Salt	0.54	
Live weight	1.86	
Bicalcium phosphate	1.40	Data obtained from suppliers on August 2011
Limestone	0.20	
L-Lysine	4.70	
MHA	9.70	
Mineral and Vitamin supplement	5.00	
L-Threonine	6.00	
Sodium bicarbonate	1.50	
Choline chloride	0.40	
Feed guard	3.58	
L-Tryptophan	61.00	
Inert	0.16	

[1]http://www.iea.sp.gov.br/

Table 4. Performance traits for broiler chicken during the period from 1 to 21 days of age

Diets	COBB-VANTRESS (2009)	Commercial	ROSTAGNO (2005)	ROSTAGNO (2011)	CV(%)
BW (g)	948.10 a	767.80 b	938.74 a	965.17 a	2.70
WG (g)	902.28 a	721.72 b	892.87 a	919.20 a	2.84
FI (g)	1280.36 a	960.62 c	1230.53 b	1227.41 b	2.35
FC (g/g)	1.420 a	1.331 b	1.377 b	1.336 c	1.02
PEI	301.54 b	185.61 c	306.66 b	324.42 a	4.79

Means followed by different letters in the same row are different ($p<0.05$).

Table 5. Performance traits for broiler chicken during the period from 1 to 42 days of age

Diets	COBB-VANTRESS (2009)	Commercial	ROSTAGNO (2005)	ROSTAGNO (2011)	CV(%)
BW (g)	2823.97 a	2270.63 b	2805.11 a	2834.30 a	2.93
WG (g)	2778.15 a	2224.55 b	2759.24 a	2788.34 a	2.99
FI (g)	4447.37 a	3545.74 b	4306.23 a	4319.48 a	3.26
FC (g/g)	1.601 a	1.594 a	1.562 b	1.547 b	1.81
PEI	411.73 a	238.47 b	411.19 a	424.85 a	3.73

Means followed by different letters in the same row are different (p<0.05).

Table 6. Average cost of the diet (ADC) and gross margin trading (MT) with respect to diet treatment

Diets	COBB-VANTRESS (2009)	Commercial	ROSTAGNO (2005)	ROSTAGNO (2011)	CV(%)
ADC (R$/ Kg)	0.709 a	1.000 c	0.730 b	0.729 b	0.11
MT	1.666 a	1.191 b	1.660 a	1.674 a	1.66

Means followed by different letters in the same row are different (p<0.05).

The TM of diet 2 was lowest (P < 0.05). Within the economic analysis, diet 1 had the lowest mean cost. Diets 1, 3 and 4 were more efficient regarding TM. The commercial diet was least attractive to producers in relation to ADC and TM.

The division of chick nutrition into several phases contributes to the reduction in feeding costs, in addition to favoring digestibility during the first week of life (STRINGHINI *et al*., 2003); this division was not performed for diet 2. Furthermore, the cost of transportation, storage and production were not accounted for in the other diets, which may have contributed to the high ADC and low TM.

The TM value of the commercial feed was also influenced by the low productive performance found. Technical efficiency does not imply economic efficiency; however, they were very similar in the present study. Other nutritional recommendations must be studied to determine optimal nutrition for broilers.

CONCLUSION

In the start phase, the ROSTAGNO *et al*. (2011) diet outperformed all others. Throughout the entire experimental period, the COBB-VANTRESS (2009), ROSTAGNO *et al.* (2005) and ROSTAGNO *et al.* (2011) diets had the best productive and economic performance for the production of broilers.

REFERENCES

ARAUJO, L.F.; JUNKEIRA, O.M.; ARAUJO, C.S.S.; SAKOMURA, N.K.; ANDREOTTI, M.O.; SUGUETA, S.M. Diferentes perfis de aminoácidos para frangos de corte no período de 43 a 56 dias de idade. **Revista Brasileira de Zootecnia**, v.31, p.387-393, 2002.

BRUM, P.A.R.; ALBINO, L.F.T.; GOMES, M.F.M.; TOSCAN, A.B.; PIENIZ, L.C. **Uso do farelo de arroz integral em dietas para frangos de corte**. Concórdia: EMBRAPA–CNPSA, 1993. 2p. (Comunicado Técnico, 201).

COBB-VANTRESS. **Suplemento:** crescimento e nutrição para frangos de corte Cobb 500. Arkansas: Cobb-Vantress, 2009, 65p.

CORRÊA, G.S.S.; SILVA, M.A.; CORRÊA, A.B.; FONTES, D.O.; SANTOS, G.G.; LIMA NETO, H.R. Nível de proteína bruta para codornas de corte durante o período de crescimento. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v.60, p.209-217, 2008.

COSTA, F.G.P.; ROSTAGNO, H.S.; ALBINO, L.F.T.; GOMES, P.C.; TOLEDO, R.S. Níveis dietéticos de lisina para frangos de corte de 1 a 21 e 22 a 40 dias de idade. **Revista Brasileira de Zootecnia,** v.30, p.1490-1497, 2001.

KOLLING, A.V.; KESSLER, A.M.; RIBEIRO, A.M.L. Desempenho e composição corporal de frangos de corte alimentados com diferentes níveis de proteína e de aminoácidos ou com livre escolha das dietas. **Revista Brasileira de Zootecnia,** v.34, p.98-103, 2005.

LEANDRO, N.S.M.; CAFÉ, M.B.; STRINGHINI, J.H.; MORAES FILHO, R.; MOURA, K.A.; SILVA JUNIOR, R.P. Plano nutricional com diferentes níveis de proteína bruta e energia metabolizável na ração, para frangos de corte. **Revista Brasileira de Zootecnia**, v.32, p.620-631, 2003.

NASCIMENTO, G.A.J.; COSTA, F.G.P.; AMARANTE JUNIOR, V.S.; BARROS, L.R. Efeitos da substituição do milho pela raspa de mandioca na alimentação de frangos de corte, durante as fases de engorda e final. **Ciências Agrotécnicas,** v.29, p.200-207, 2005.

OLIVEIRA, R.F.M.; DONZELE, J.L.; ABREU, M.L.T.; FERREIRA, R.A.; VAZ, R.G.M.V.; CELLA, P.S. Efeitos da temperatura e da umidade relativa sobre o desempenho e o rendimento de cortes nobres de frangos de corte de 1 a 49 dias de idade. **Revista Brasileira de Zootecnia**, v.35, p.797-803, 2006.

ROSTAGNO, H.S.; ALBINO, L.F.T.; DONZELE, J.L.; GOMES, P.C.; OLIVEIRA, R.F.; LOPES, D.C.; FERREIRA, A.S.; BARRETO, S.L.T. **Tabelas brasileiras para aves e suínos:** composição de alimentos e exigências nutricionais. 2.ed. Viçosa: UFV, Departamento de Zootecnia, 2005. 186p.

ROSTAGNO, H.S.; ALBINO, L.F.T.; DONZELE, J.L.; GOMES, P.C.; OLIVEIRA, R.F.; LOPES, D.C.; FERREIRA, A.S.; BARRETO, S.L.T. **Tabelas brasileiras para aves e suínos:** composição de alimentos e exigências nutricionais. 3.ed. Viçosa: UFV, Departamento de Zootecnia, 2011. 252p.

SÁ, L.M.; GOMES, P.C.; ALBINO, L.F.T.; ROSTAGNO, H.S.; D'AGOSTINI, P. Exigência nutricional de cálcio e sua biodisponibilidade em alguns alimentos para frangos de corte, no período de 1 a 21 dias de idade. **Revista Brasileira de Zootecnia**, v.33, p.157-168, 2004.

SABINO, H.F.N.; SAKOMURA, N.K.; NEME, R.; FREITAS, E.R. Níveis proteicos na ração de frangos de corte na fase de crescimento. **Pesquisa Agropecuária Brasileira**, v.39, p.407-412, 2004.

STRINGHINI, J.H.; DI RESENDE, A.; CAFÉ, M.B.; LEANDRO, N.S.M.; ANDRADE, M.A. Efeito do peso inicial dos pintos e do período da dieta pré-inicial sobre o desempenho de frangos de corte. **Revista Brasileira de Zootecnia**, v.32, p.353-360, 2003.

VASCONCELLOS, C.H.F. **Efeito de diferentes níveis de proteína bruta e suplementação de L-glicina sobre o desempenho de frangos de corte machos de um a 21 dias de idade**. 2009. 134f. Tese (Doutorado) -Universidade Federal de Minas Gerais, Belo Horizonte, 2009.