EVALUATION OF VARIED DIETARY CRUDE PROTEIN AND LYSINE LEVEL AT 5.7% OF CRUDE PROTEIN ON PRODUCTIVE PARAMETERS IN BROILER CHICKENS.

Evaluación de diferentes niveles de proteína cruda y lisina al 5,7% de proteína cruda sobre parámetros productivos de pollos de engorde.

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ABSTRACT

An experiment was carried out to evaluate the performance of 1-18 d broiler chickens to dietary crude protein (CP) levels from 170 to 250 g CP/kg diet and the dietary lysine level formulated at 5.7% of CP level. Thus, the dietary lysine level of diets increased as CP increased. Body weight gain of chicks was affected at ages from 1 to 18 days by the CP and lysine levels. Birds fed the most protein diets at ages from 0 to 7 and 7 to 14 days were heaviest (P<0.05) for dietary CP of 25 vs 19 and 17%. Increased body weight gain (0-18 d) (P<0.05) was found with increasing dietary CP from 210 to 250 g CP/kg diet compared to lower CP levels. Dietary treatments had no effect on daily feed intake (g/b/d) when CP levels were 190 to 250 g CP/kg diet (P>0.05). There was a reduced feed intake with dietary CP at 170 g CP/kg diet (P<0.05). As dietary crude protein increased there was an increase of about 31% in carcass nitrogen deposition (mg/b/d) when chicks were fed diets from 210 to 250 g CP/kg diet compared to the lower CP diets (P<0.05). A decrease in carcass fat deposition (g/b/d) was found as dietary CP increased from 170 to 250 g CP/kg diet. This study indicates that if lysine to CP ratio is kept constant at 5.7%, maximal productive performance of broiler chickens to 18 days can be achieved among 21 and 25% CP. Choosing among diets will depend mainly on cost of the dietary protein.

Key words: Broilers, crude protein, lysine level, weight gain, carcass nitrogen.

RESUMEN

Un experimento fue realizado con el fin de evaluar la respuesta productiva y deposición de N y grasa en pollos de engorde desde el 1 a los 18 días de edad alimentados con niveles de proteína cruda (PC) variando desde los 170 a los 250 g PC/kg dieta y el nivel de lisina formulado al 5,7% del nivel de PC de la dieta. La ganancia de peso fue afectada en todas las edades por los niveles de PC y lisina. Las aves alimentadas con dietas conteniendo 210; 230 y 250 g CP/kg, desde el 1 a los 14 días de edad, presentaron mayor peso (P<0,05). Un aumento en la ganancia de peso (0-18 d) (P<0,05) se encontró al incrementar los niveles de PC de 210 a 250 g PC/kg y compararlos con menores niveles de PC. El consumo diario de alimento (g/a/d) no fue afectado cuando los niveles de PC fueron de 190 a 250 g PC/kg (P>0,05). Se encontró una disminución en el consumo de alimento con dietas conteniendo 170 g PC/kg (P<0,05). Se observó una tendencia de mejorar la conversión alimenticia (C: A) al suministrar altas concentraciones de PC en la dieta. Las aves alimentadas con 210 a 250 g PC/kg obtuvieron un incremento de aproximadamente un 31% en la deposición de nitrógeno en la canal (mg/a/d) comparados con las aves alimentadas con menores niveles de PC (P< 0,05). La deposición de grasa (g/a/d) en la canal de las aves disminuyó al aumentar la proteína en la dieta desde los 170 a 250 g PC/kg. Este estudio sugiere que, cuando el radio de lisina: PC es mantenido a 5,7%, un desarrollo productivo máximo en pollos de engorde a los 18 días de edad puede ser alcanzado con dietas entre 21 a 25% de PC. La escogencia del nivel de proteína dependerá principalmente del costo de la dieta.

Palabras clave: Pollos de engorde, proteína cruda, nivel de lisina, ganancia de peso, deposición de nitrógeno en la canal.

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INTRODUCTION

Dietary protein content has re-emerged as a topic of interest and importance over the last few years mainly due to environmental concerns. An increasing understanding of protein utilization has allowed to meet more closely the amino acid requirements of broiler chickens at various stages of growth. The primary function of protein is to supply essential amino acids (EAA). Lysine is usually the second limiting amino acid in commercial broiler diets and other EAA are balanced with this in applying the concept of ideal protein. Lysine is used as the reference AA mainly due to its importance for protein accretion and maintenance, the fact that its determination is relative easy, and numerous data have been collected for poultry [7, 18]. The advantage of the concept of ideal AA pattern is that requirements of other EEA can be easily established under various conditions (environmental, sex, dietary factors) if lysine requirements are accurately known. Research has been conducted to determine the lysine requirements of broiler chickens [8, 16, 20, 21, 22]. However, the need for EAA may vary with the crude protein (CP) level of the diet [27, 28]. In developing countries and/or when the price of soybean meal increases, a need for alternative ingredients occur which might imply formulating diets higher in CP than is usually deemed necessary in order to meet normal levels of amino acids. It has been suggested that the amount of lysine needed to maximize growth rate when dietary CP varies from 140 to 280 g CP/kg diet is about 54 g lysine/kg CP [1, 27], which implies a linear relationship between this amino acid and protein content of a diet.

The objective of the present experiment was to evaluate in 1-18 d broiler chickens, the effect of fixing the lysine: protein ratio in the diet at crude protein levels ranging from 170 to 250 g CP/kg diet.

MATERIALS AND METHODS

Experiments

Two hundred and forty one day-old male broiler chickens of a commercial strain (Ross x Ross) were randomly allocated to one of five treatments of 48 chicks each. Each treatment consisted of six replicates of 8 birds each. The experiment was repeated in time, thus a total of 96 birds were used for each treatment. Chicks were housed in an electrically heated battery brooder where feed and water were available *ad libitum*. Lighting was provided 23h/day. All birds were fed *ad libitum* to 18 d of age with one of 5 experimental diets. Experimental diets were individually formulated and provided 170, 190, 210, 230 or 250 g CP/kg diet while the lysine level was fixed at 5.7% CP. Other amino acids were formulated according to the ideal ratio as suggested by Baker and Han [7].

At day 7, all birds were wing-banded and individually weighed, and then reweighed at weekly intervals and at 18 d of age. Cage mean feed intake and feed efficiency were also calculated, and all mortalities were recorded. At the start of the experiments (day 1) 8 representative birds, based on average body weight, were killed and the entire carcasses pooled and frozen for subsequent analyses. At 18 d of age, random samples of 4 birds per cage were euthanized by cervical dislocation and the complete carcasses pooled and then frozen for estimates of nitrogen and fat deposition. Carcass yield for each treatment group was assessed as the mean of 48 chickens. In all cases birds were deprived of food for about four hours before being killed and carcass analyses were determined for the entire body including feathers. Broiler carcasses were autoclaved (Amsco Eagle Gravity, Eagle Series, 2021) U.S.A., at 120°C for 35 minutes, cooled and then ground in a commercial blender (Waring Products Division, New Hartford, CT 06057-0000). Carcass nitrogen determination was assessed using a Leco nitrogen analyzer (Leco Instruments, Stockport, Cheshire, SK7 5DA, UK). Analyses for ether extract were assessed according the Association of Official Analytical Chemists procedures [5].

Statistical Analysis

Not significant differences were found when ANOVA procedure was used for variation in time period, thus the experiment was arranged as a complete randomized block design with replicate as the experimental unit. A one-way ANOVA was used to test the effect of dietary treatments. Response variables having a significant F test ($P<0.05$) were analyzed using Tukey's studentized range test [32].

RESULTS AND DISCUSSION

The calculated proximate analysis and the determined crude protein (CP) and lysine levels of the experimental diets are shown in TABLE I. Dietary lysine level of diets increased as CP increased in the diet so as to maintain the lysine: CP ratio at around 5.7% CP. However, there was a lower concentration than estimated for lysine in the diet containing 230 g CP/kg diet (TABLE I). The results of the production parameters in relation to varied dietary crude protein and lysine levels are shown in TABLES II and III. Body weight gain was affected ($P< 0.05$) at all ages by dietary CP and lysine levels (TABLE II). As early as 7 d of age, dietary protein with lysine at 5.7% CP influenced weight gain (TABLE II). No significant differences ($P> 0.05$) were noted in weight gain of chicks fed among 25, 23 and 21% CP. Birds fed the most protein were heaviest, and this was significant ($P<0.05$) for 25% vs 19% and 17% CP. When evaluating the effect of diet protein from 0-18 d of age, an increased body weight gain was found with increasing dietary CP from 210 to 250 g CP/kg diet compared to diets at 170 and 190 g CP/kg ($P<0.05$) (TABLE II). It was obvious that variation in the parameters measured depended on the crude protein and lysine intakes. Previous research using low CP diets suggested that the supply of amino N as non-essential amino acids (NEAA) affects growth and feed conversion [9, 23,

TABLE I
EXPERIMENTAL DIETS COMPOSITION/ COMPOSICION DE DIETAS EXPERIMENTALES

Ingredients	Crude Protein (%)				
	25	23	21	19	17
Soy bean (48%)	451.882	414.094	318.846	276.408	219.095
Corn	279.346	254.304	575.082	580.153	662.386
Corn Starch	196.822	269.101	37.121	79.895	29.532
Animal Veg-Fat	23.086	12.924	15.780	10.00	20.00
Limestone	15.968	15.651	16.266	16.032	15.994
Dicalcium Phospahte[2]	10.824	11.686	11.363	12.115	12.641
Salt	3.641	3.720	3.431	3.478	3.445
Vitamin-Mineral Premix	10.00	10.00	10.00	10.00	10.00
L-Lysine HCL	-	-	1.222	1.430	1.835
DL-Methionine	3.968	4.088	2.93	2.604	2.299
L-Threonine	4.462	4.431	2.959	2.885	2.234
Cellulose	-	-	-	5.00	20.00
Calculated Analysis					
ME (kcal/kg)	3000	3000	3000	3017	3031
Lysine (%)	1.43	1.31	1.20	1.09	0.97
Methione + Cystine (%)	1.13	1.08	0.95	0.86	0.78
Threonine (%)	1.00	0.95	0.80	0.75	0.65
Tryptophan (%)	0.35	0.30	0.26	0.24	0.21
Sodium (%)	0.18	0.18	0.18	0.18	0.18
Calcium (%)	0.95	0.95	0.95	0.95	0.95
Av. Phosphorus (%)	0.42	0.42	0.42	0.42	0.42
Fat (%)	3.799	2.66	4.066	3.471	4.716
Fiber (%)	1.536	1.404	2.317	2.234	3.767
Determined Analysis (%)					
Crude Protein	25.1	23.7	21.8	20	17.4
Lysine	1.47	1.17	1.21	1.11	1.01

Supplied per kilogram of diet: vitamin A, 8,800 IU (retinyl palmitate); vitamin D_3, 3,300 IU; vitamin E, 40 IU (dl-α-tocopheryl acetate); riboflavin, 8.0 mg; biotin, 0.22 mg; thiamin, 4 mg; pantothenic acid, 15.0 mg; vitamin B_{12}, 12 µg; niacin, 50 mg; choline, 600 mg; vitamin K, 3.3 mg; folic acid, 1.0 mg; ethoxyquin, 120 mg; manganese, 70 mg as manganous oxide 60%; zinc, 70 mg as zinc oxide 72%; copper, 10 mg as copper sulphate 25%; iron, 60 mg as ferrous sulphate 30%; iodine, 1 mg, and selenium, 0.3 mg. [2] Contained 23% Ca and 20% P.

26]. Current results suggest that even when essential amino acids are not limiting in low CP diets a need for N in a form of NEAA is necessary to optimize growth. This fact is in accord with the findings of [11] indicating that even when meeting or exceeding [30] recommendations of EAA in low CP diets, broiler performance goals are not achieved compared to birds fed more normal levels of CP diet. However, Aletor et al [2] observed no difference in growth of broilers fed with dietary CP ranging from 153 to 225 g CP/Kg diet while meeting the minimum [30] recommendations for EAA. It is likely that any excess of EAA would be transaminated for NEAA synthesis in low CP diets although, excess of EAA are used rather efficiently for NEAA biosynthesis [3]. These same authors suggested that the efficiency of lysine used for synthesis of glutamate is only about 45%, which implies an extra energetic cost for NEAA biosynthesis that could aid in the explanation of the reduced growth in chicks fed low CP diets. Transamination of EAA increases the synthesis of NEAA and promotes of uric acid. The cost of energy for uric acid synthesis has been estimated of 18 ATP per mole [12]. It is suggested that the reduced response observed in chicks subjected to low CP diets with lysine at about 5.7% CP is due to an insufficiency of amino N. Baker [6] suggested that the efficiency of utilization of a protein or an amino acid is constant from zero up to the minimal requirement for maximal protein accretion. The reduced weight gain observed in chicks fed a dietary CP of 25% with lysine fixed at

TABLE II

WEIGHT GAIN OF BROILER CHICKENS FED LYSINE FIXED AT 5.7% OF CRUDE PROTEIN LEVELS /
GANANCIA DE PESO EN POLLOS DE ENGORDE ALIMENTADOS CON LISINA FIJADA AL 5,7% DEL NIVEL DE LA PROTEINA CRUDA

% Crude Protein	% Lysine	Weight Gain (g)				
		0 – 7 d	7 – 14 d	0 – 14 d	0 – 18 d	g/b/d
25	1.47	105^{a}	208^{ab}	312^{a}	473^{a}	26.3^{a}
23	1.17	97^{abc}	190^{a}	288^{ab}	449^{ab}	25.0^{ab}
21	1.21	99^{ab}	212^{b}	312^{a}	490^{a}	27.2^{a}
19	1.11	95^{bc}	195^{ab}	289^{ab}	427^{b}	23.7^{b}
17	1.01	91^{c}	189^{a}	280^{b}	430^{b}	23.9^{b}
SEM		0.94	2.44	3.16	4.9	0.27

a-c Means within a column with no common superscript differ significantly (P<0.05). SEM: standard error of mean.

TABLE III

FEED CONVERSION AND FEED INTAKE OF BROILERS CHICKENS FED LYSINE FIXED AT 5.7% OF CRUDE PROTEIN LEVELS/ CONVERSION ALIMENTICIA Y CONSUMO DE ALIMENTO EN POLLOS DE ENGORDE ALIMENTADOS CON LISINA FIJADA AL 5,7% DEL NIVEL DE LA ROTEINA CRUDA

% Crude Protein	% Lysine	Feed Conversion (F:G)				Feed Intake
		0 -7 d	7 – 14 d	0 – 14 d	0 to 18 d	g/b/d
25	1.47	1.08^{a}	0.98	1.01^{a}	1.00^{a}	25.8^{a}
23	1.17	1.16^{b}	0.97	1.03^{a}	1.06^{ab}	26.5^{a}
21	1.21	1.24^{c}	1.00	1.08^{ab}	1.06^{ab}	27.4^{a}
19	1.11	1.30^{c}	1.02	1.11^{ab}	1.09^{ab}	26.0^{a}
17	1.01	1.37^{d}	1.05	1.16^{b}	1.13^{b}	23.1^{b}
SEM		0.014	0.015	0.012	0.013	0.45

a-c Means within a column with no common superscript differ significantly (P<.05). SEM: standard error of mean.

5.7% CP might be explained as an increased oxidation of the amino acid necessitating an extra energy cost, and therefore less net energy would be available for production. Macleod [25] suggested that 6 mol ATP/mol amino acid is the cost of excretion of N from AA. When supplying amino acid in excess of the immediate need for protein synthesis their oxidation increases [13], and so the supplied of amino acids are more efficiently used for protein synthesis when supplied at moderate or requirement levels. Nieto et al. [29], evaluated the effect of protein quality on energy requirements and energy cost for protein and fat deposition and indicated utilization of ME for production to be negatively correlated with protein quality of diets. The same authors found that the energy retained as fat increases as protein quality declines. A quality of a protein is referred as the profile of the EAA in the proper order to meet the requirements of particular species [24]. It is implicit that even though high CP diets allow for maximal growth, this will not occur with an imbalanced mixture of AA's.

Diet had no effect on daily feed intake (g/b/d) with dietary CP ranging from 190 to 250 g CP/kg diet (P>0.05) and only with dietary CP diets at 170 g CP/kg there was a reduced feed intake (P<0.05). A noticeable improvement in feed conversion (F:G) from the first week of age was found when higher concentrations of CP were fed (P<0.05). Feed conversion from 0-18 d was not different (P>0.05) for the different diet protein and lysine levels although, differences were noted (P<0.05) when comparing 250 vs 170 g CP/kg diets. Fat, carbohydrate and protein all exert an effect on food consumption although, it is suggested that protein produces the greatest effect in the control of food intake [10]. Results observed in the experiment suggest that feed intake was influenced by dietary crude protein and lysine levels. Previous research conducted with broiler chickens indicate that feed intake is affected by dietary CP and amino acid levels [2, 31] and that, in humans at least, the proportion of circulating amino acids are related to a series of events that affect appetite [10]. D'Mello and Lewis [15] reported that when chicks were fed an imbalanced diet the plasma amino acid profile was altered. The fact that birds may have an ability to control protein and/or amino acid intake [14] and that they eat to fulfill their EAA requirements [33] suggest that feed intake may be related to the crude protein and lysine intakes. However no significant differences (P>0.05) were observed in feed intake in chicks fed dietary CP ranging from 190 to 250 g CP/kg diet. A significant (P< 0.05) reduction in feed intake was observed with the lowest CP diets (17%). Emmert et al [19] suggested a relationship between feed intake and CP, especially at low levels of CP, a situation seen in the current studies. It has been previously suggested that when chicks are fed diets deficient in amino acids [4] and/or excesses of amino acids, feed intake is reduced [15]. However, with the low CP diets used here, dietary lysine levels determined were at or above 1% of the diet, suggesting that it was not lysine, but rather protein per se, which affected feed intake.

Carcass nitrogen and fat deposition in chicks to 18 d of age are presented in FIGS. 1 and 2. Carcass nitrogen deposition (mg/b/d) increased as dietary CP increased, which resulted in an increased carcass nitrogen deposition of about 31% in diets ranging from 210 to 250 g CP/kg diet compared to 170 and 190 g CP/kg diet (P<0.05). There was also a decrease in carcass fat deposition (g/b/d) as dietary CP was increased. Carcass nitrogen and fat deposition were related to CP of diet. An improved (P<0.05) carcass protein accretion was observed when chicks were fed 210 to 250 g CP/Kg diet. Similar responses using diets varying in CP have been reported [2, 11, 19]. Eits et al [17] indicated that protein deposition increases as amino acid intake increases. This correlates with the results of the present experiment where lysine was fixed at 5.7% CP, wherein as lysine and CP intakes were increased carcass nitrogen deposition was improved. A reduced AA intake of around 6% was noted in the two lowest CP treatments which had different (P<0.05) carcass protein deposition compared to the 210 to 250 g CP/Kg diet. This significant difference however, was most likely related to a reduction of about 40% in the CP intake between both dietary treatments. Fat deposition tended to decrease as dietary CP was increased suggesting that after the minimal protein/AA requirements are achieved any excess is degraded and used for fat synthesis following its deamination. However, the energy required to catabolize the excess of protein and/or AA may explain the situation by which increasing dietary CP level fat deposition is reduced. These results are in agreement with [2] and [11], who observed an increase in fat deposition (g/chick) as dietary CP was reduced.

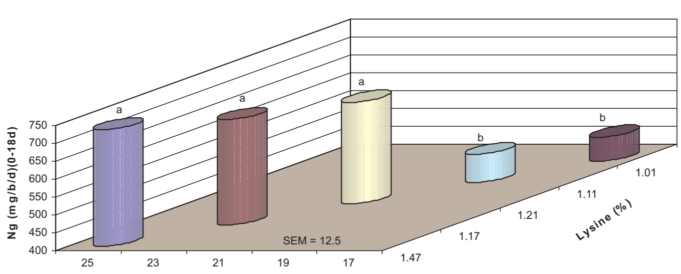

FIGURE I. NITROGEN GAIN IN BROILER CHICKENS FED LYSINE FIXED AT 5.7% OF CRUDE POTEIN/ GANANCIA DE NITRÓGENO EN POLLOS DE ENGORDE ALIMENTADOS CON LISINA AL 5,7% DEL NIVEL DE LA PROTEÍNA CRUDA.

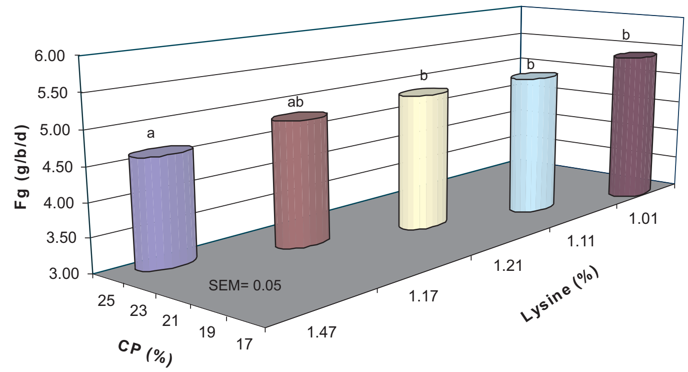

FIGURE 2. CARCASS FAT DEPOSITION IN BROILER CHICKENS FED LYSINE FIXED AT 5.7% OF CRUDE PROTEIN/ DEPOSICIÓN DE GRASA EN LA CANAL DE POLLOS DE ENGORDE ALIMENTADOS CON LISINA FIJADA AL 5,7% DEL NIVEL DE LA PROTEÍNA CRUDA.

CONCLUSIONS

The results obtained in the current experiment support the idea that when lysine to CP ratio is kept constant at 5.7%, maximal productive performance of broiler chickens to 18 days can be achieved among 21 and 25% CP. However, a 25% CP diet will yield a significant lower carcass fat content. Choosing among diets will depend on cost on the dietary protein and consumer preferences.

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