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Accuracy of OmniPro® Predictions for Amino Acid Needs Without Minimum Crude Protein Requirement[1]

E. O. Oviedo-Rondón, C. A. Fritts and P. W. Waldroup
Poultry Science Department, University of Arkansas, Fayetteville, AR, 72701, USA
E-mail: waldroup@uark.edu

Abstract: The use of computerized mathematical growth models to estimate accurate and profitable dietary amino acid needs for broilers is a promising alternative to use of fixed requirements. Estimation of crude protein needs by the OmniPro® II growth model is higher than minimum CP levels known to support maximum broiler performance. In this experiment, male broilers were fed either a series of diets formulated using OmniPro® estimations for total amino acids and CP, or a series of diets formulated to provide from 90 to 105% of amino acids estimations made by OmniPro without a CP minimum. Results indicated that diets formulated based on OmniPro total amino acid estimations, with or without minimum crude protein constraints, supported the best live performance and carcass traits.

Key words: Growth models, amino acid requirements, low crude protein

Introduction

OmniPro® II[2] is a semi-mechanistic, deterministic and dynamic growth model designed to simulate and optimize nutritional changes (Hurwitz and Talpaz, 1999; Ivey, 1999). In a recent study (Oviedo-Rondón *et al*., 2002), the OmniPro® II estimations of amino acids and energy requirements for a commercial broiler feeding program were evaluated for different genders. Results of this experiment indicated that the OmniPro program estimated acceptable amino acid requirements, compared to diets formulated according to NRC (1994) recommendations. However, the crude protein levels estimated by the OmniPro model were higher than those observed to support maximum live performance (Si *et al*., 2000; Jiang *et al*., 2001). In the present study the amino acid and energy requirement estimations made by OmniPro® II for male Cobb-500 broiler chickens were evaluated with no minimum total crude protein content specified in the formulation. The objective was to determine the most appropriate amino acid level from the growth model estimations without minimum crude protein restriction for diets fed in a commercial feeding program for male broiler chickens.

Materials and Methods

Requirement estimates: To achieve accuracy in estimation of nutritional needs, OmniPro® II uses tools to calibrate its values based on historical variables that affect broiler growth. For this experiment, OmniPro® II was calibrated based on: 1. Genetic line growth curve of male Cobb-500 broiler chickens; 2. Historical in-house weekly temperature recorded at the University of Arkansas research farm; 3. Bird density; and 4. Body weight observed previously at the research farm with this genetic line.

To obtain nutritional requirement values for the growth model, it is necessary to indicate the feeding program used. The feeding program consisted of: starter (1 to 14 d), grower (15 to 35 d) and finisher (35 to 49 d) diets, corresponding to the most common feeding program at present in the United States. Corn, soybean meal, and poultry oil of known composition served as the primary sources of protein and energy. The OmniPro® II program optimized the requirements to sustain the specified growth rate for each period under the feeding program, temperature, and density conditions specified.

Diets and treatments: There were seven experimental treatments, consisting of one series of diets formulated with full crude protein and amino acid levels as calculated by the OmniPro model, and six treatments in which the total amino acid content of the diets were formulated to be 90, 95, 100, 105, 110 and 115% of the model amino acid estimations without minimum crude protein content. Compositions of the diet with full CP and the diets with 90 and 115% amino acid without a CP minimum for each feeding period are shown in Table 1. Diets with 95 to 110% were intermediate in composition and are not shown for brevity.

The diets were formulated according to amino acid

[1]Published with approval of the Director, Arkansas Agricultural Experiment Station, Fayetteville, AR. Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the University of Arkansas and does not imply its approval to the exclusion of other products that may be suitable.
[2] Novus International, Inc., St. Charles MO 63304.

Table 1: Composition (g/kg) of experimental diets formulated according to OmniPro® II estimations

Ingredients	Starter (1 - 14D)			Grower (14 - 35D)			Finisher (35 - 49D)		
	Full CP	90%	115%	Full CP	90%	115%	Full CP	90%	115%
Yellow corn	501.48	639.25	500.66	568.41	645.69	493.43	642.08	717.45	580.92
Soybean meal (49%)	416.44	296.64	412.89	341.62	275.67	404.46	272.01	207.84	323.18
Poultry oil	39.99	18.44	40.33	49.54	37.40	61.47	48.57	36.87	58.33
Ground limestone	17.02	17.84	17.06	16.01	16.45	15.59	14.91	15.34	14.57
Dicalcium phosphate	11.92	12.23	11.92	10.90	11.07	10.74	10.15	10.32	10.02
L-Lysine HCl (98%)	0.00	2.05	2.37	0.00	0.44	0.00	0.00	0.00	0.00
Alimet 88%[1]	1.62	1.94	3.23	2.43	2.15	3.26	1.65	1.51	2.38
Iodized Salt	5.28	5.36	5.29	4.84	4.88	4.8	4.38	4.42	4.35
Vitamin premix[2]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Trace mineral mix[3]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Choline Cl (60%)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Coban 60[4]	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
BMD-50[5]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00	1000.00

[1]Source of methionine hydroxyanalogue. Novus International, St. Charles MO 63304. [2]Provided per kg of diet: vitamin A (from vitamin A acetate) 7714 IU; cholecalciferol 2204 IU; vitamin E (from dl-alpha tocopheryl acetate) 16.53 IU; vitamin B_{12} 0.013 mg; riboflavin 6.6 mg; niacin 39 mg; pantothenic acid 10 mg; choline 465 mg; menadione (from menadione dimethylpyrimidinol) 1.5 mg; folic acid 0.9 mg; thiamin (from thiamine mononitrate) 1.54 mg; pyridoxine (from pyridoxine hydrochloride) 2.76 mg; d-biotin 0.066 mg; ethoxyquin 125 mg; Se 0.1 mg. [3]Provided per kg of diet: Mn (from $MnSO_4 \cdot H_2O$) 100 mg; Zn (from $ZnSO_4 \cdot 7 H_2O$) 100 mg; Fe (from $FeSO_4 \cdot 7 H_2O$) 50 mg; Cu (from $CuSO_4 \cdot 5 H_2O$) 10 mg; I (from $Ca(IO_3)_2 \cdot H_2O$) 1 mg. [4] Elanco Animal Health division of Eli Lilly & Co., Indianapolis, IN 46825. [5]Alpharma, Inc., Ft. Lee, NJ 07024.

requirements obtained from predictions made by the OmniPro® II. The nitrogen and energy content of the supplemental amino acids was considered in formulation (NRC, 1994). These diets were formulated to be isocaloric in each period (Table 2). The other nutrient levels were specified as suggested by the NRC (1994). These diets were fed according to the commercial feeding schedule indicated above. All diets were fortified with complete vitamin and mineral premixes obtained from commercial broiler producers and contained monensin (90 g/ton) and bacitracin methylene disalicylate (50 g/ton). All diets were fed in mash form. All diets were analyzed for crude protein, total amino acid content and amount of methionine hydroxy analogue added and were found to be in good agreement with calculated values (Table 2).

Birds and housing: Male chicks of a commercial broiler strain[3] were obtained from a local hatchery where they had been vaccinated in ovo for Marek's virus and had received vaccinations for Newcastle Disease and Infectious Bronchitis post hatch via a coarse spray. Twenty-five male chicks were placed in each of 28 pens for a total of 700 birds. Four pens were assigned to each of the seven treatments. Each pen was equipped with one automatic water fount and one tube-type feeder. New softwood shavings were used as litter.

Measurements and statistical analysis: Birds were group weighed by pen at 14, 35, and 49 d of age, with feed consumption determined at the same time. Mortality and environmental temperature were recorded daily. The weight of dead birds was used to adjust feed conversion. At 49 d, five birds per pen were randomly selected for processing. Feed but not water was withheld for 8 h prior to processing. The birds were placed in coops and transported 2 km to a pilot

[3] Cobb-Vantress, Inc., Siloam Springs AR 72761.

Table 2: Nutrient content (%) of diets formulated according to OmniPro® II estimations

Nutrients[1]	Starter (1 - 14 D)			Grower (14 - 35 D)			Finisher (35 - 49 D)		
	Full CP	90 %	115 %	Full CP	90 %	115 %	Full CP	90 %	115 %
ME, kcal/kg	3024	3024	3024	3144	3144	3144	3213	3213	3213
Crude protein (C)	24.46	20.02	24.51	21.40	18.90	23.81	18.65	16.18	20.61
Crude protein (A)	24.84	19.52	25.04	22.10	19.36	25.47	18.70	16.42	20.53
Lysine (C)	1.39	1.22	1.56	1.18	1.04	1.35	0.99	0.81	1.13
Lysine (A)	1.46	1.27	1.56	1.23	1.05	1.54	0.99	0.82	1.12
Methionine (C)	0.52	0.49	0.66	0.55	0.49	0.65	0.45	0.40	0.53
Methionine (A)	0.38	0.33	0.37	0.36	0.32	0.42	0.31	0.28	0.33
Cystine	0.39	0.33	0.39	0.35	0.32	0.38	0.31	0.28	0.34
Met+Cys	0.91	0.82	1.05	0.9	0.81	1.04	0.76	0.68	0.87
Tryptophan	0.35	0.26	0.34	0.29	0.25	0.34	0.25	0.20	0.28
Threonine (C)	0.94	0.75	0.93	0.82	0.71	0.92	0.71	0.61	0.79
Threonine (A)	0.94	0.78	0.94	0.83	0.71	1.02	0.71	0.61	0.80
Isoleucine	1.05	0.83	1.04	0.90	0.78	1.02	0.77	0.66	0.87
Valine	1.15	0.93	1.14	1.00	0.88	1.12	0.87	0.76	0.97
Leucine	2.09	1.77	2.08	1.87	1.70	2.04	1.68	1.51	1.82
Arginine	1.67	1.30	1.66	1.43	1.22	1.62	1.21	1.01	1.37
Phenylalanine	1.19	0.95	1.18	1.03	0.90	1.15	0.89	0.77	0.9
Tyrosine	0.98	0.78	0.97	0.85	0.74	0.95	0.73	0.63	0.82
Calcium	0.95	0.95	0.95	0.87	0.87	0.87	0.80	0.80	0.80
Nonphytate P.	0.72	0.70	0.70	0.67	0.66	0.68	0.63	0.62	0.64
Chloride	0.45	0.45	0.45	0.42	0.42	0.42	0.39	0.39	0.39
Sodium	0.37	0.42	0.37	0.34	0.35	0.34	0.32	0.32	0.32

[1]Values are calculated unless indicated as being analyzed (A). Values for methionine are below estimates because methionine hydroxy analogue was used as a source of supplemental methionine.

processing plant where they were slaughtered using automatic mechanical evisceration. Trained technicians determined dressing percentage and parts yield.

Pen means were used as the experimental unit. The data were analyzed as straight analyses of variance in a completely random design (SAS Institute, 2000). Regression analysis was performed for data of treatments where levels of protein and amino acids varied from 90 to 115% of OmniPro estimations to determine the most optimum level of estimation. Mortality was transformed to $\sqrt{n+1}$ prior to analysis; data are presented as natural numbers. All statements of statistical significance were based on a probability of P # 0.05.

Results and Discussion

Live performance: Live performance on the various treatments is shown in Table 3. At 14 d, there was no significant difference in body weight among birds fed the different experimental diets. At 35 and 49 d, birds fed the diets with 90% Omnipro® II amino acid estimates were significantly smaller than all other groups, with no significant difference among the other treatments. However, linear regression analysis indicated a requirement of 107.5% of the amino acid estimations for maximum growth (R^2 = 0.48). Feed conversion did not differ among groups at 14 d or from 14 to 35 d. From 35 to 49 d, and from 0 to 49 d, significant differences were observed among the various treatments. Within the groups fed the various percentages of amino acid estimation without

TABLE 3: Live performance of male Cobb-500 broilers fed diets formulated according to OmniPro® II model estimations (four pens of 25 males per treatment)

Measurement	OmniPro Full protein	OmniPro® II diets with reduced protein						ANOVA		
		90 %	95 %	100%	105%	110%	115%	P values	SEM	CV %
14 d BW (kg)	0.414^{a}	0.391^{a}	0.399^{a}	0.400^{a}	0.417^{a}	0.420^{a}	0.406^{a}	0.067	0.010	4.93
0-14 d FCR (g:g)	1.138	1.201	1.167	1.193	1.163	1.138	1.168	0.7996	0.034	5.90
35 d BW (kg)	1.976^{a}	1.865^{b}	1.965^{a}	1.953^{a}	1.977^{a}	2.018^{a}	1.982^{a}	0.0001	0.027	2.77
14-35 d FCR (g:g)	1.685	1.789	1.673	1.712	1.708	1.651	1.682	0.1948	0.034	4.02
49 d BW (kg)	3.343^{a}	3.180^{b}	3.290^{a}	3.334^{a}	3.337^{a}	3.373^{a}	3.341^{a}	0.0001	0.038	2.32
35-49 d FCR (g:g)	2.093^{bc}	2.178^{b}	2.196^{ab}	2.129^{b}	2.079^{bc}	2.121^{b}	1.994^{c}	0.0012	0.041	3.87
0-49 d FCR (g:g)	1.778^{bc}	1.876^{a}	1.812^{ab}	1.817^{ab}	1.788^{bc}	1.765^{c}	1.734^{c}	0.0083	0.024	2.69
Mortality (%)	2.00	0.00	4.00	3.00	3.00	6.00	1.00	0.3664	1.871	1.79
Culled (%)	1.00	0.00	2.00	3.00	0.00	0.00	1.00	0.1531	0.817	0.80

[a-d] Means within a row lacking a common superscript differ significantly ($P < 0.05$).

Table 4: Carcass characteristics of male Cobb-500 broilers fed diets formulated according to OmniPro® II growth model estimations or NRC (1994) recommendations at 49 d of age

Measurements	Omnipro full protein	OmniPro® II diets with reduced protein						ANOVA		
		90%	95%	100%	105%	110%	115%	P VALUES	SEM	CV %
Body weight (kg)	3.279^{abc}	3.152^{c}	3.318^{ab}	3.394^{ab}	3.331^{ab}	3.431^{a}	3.262^{bc}	0.0001	0.057	7.85
Dressing percent[1]	71.8^{a}	71.2^{ab}	71.6^{ab}	71.9^{a}	71.8^{a}	72.0^{a}	71.1^{b}	0.0474	0.298	1.46
Carcass traits[2]										
Breast yield	26.5^{ab}	25.1^{cd}	26.0^{abc}	26.3^{ab}	26.8^{a}	26.3^{ab}	26.4^{ab}	0.0101	0.318	3.02
Leg quarter	33.7	33.9	34.2	33.7	33.6	33.9	34.0	0.3298	0.292	2.22
Wing	10.9^{b}	10.9^{b}	10.7^{b}	10.8^{b}	10.7^{b}	10.8^{b}	10.9^{b}	0.0052	0.114	2.42
Abdominal fat	1.37^{bc}	2.00^{a}	1.66^{ab}	1.60^{b}	1.58^{b}	1.55^{b}	1.08^{c}	0.0059	0.140	20.92

[1]Dressed carcass without giblets as percentage of live carcass prior to slaughter. [2]Parts yield expressed as percentage of chilled carcass weight. [a-d]Means within a row lacking a common superscript differ significantly ($P < 0.05$).

a protein restriction, feed conversion usually improved in a linear manner as the percentage estimation increased. Feed conversion on the diets with 95% or more of the amino acid estimations was not significantly different from that of birds fed diets with the full CP and amino acid estimation. Therefore it may be concluded that under the conditions of this experiment, diets formulated without minimum crude protein restriction, but with at least 95% of all the amino acid levels estimated by the computer growth model can support BW and FCR similar to the full crude protein diet. No significant differences were observed among treatment groups in rate of mortality or number of birds culled for various reasons.

Although there were no significant differences ($P > 0.05$) during the starter period in live performance among treatments fed with all reduced protein diets, is not advisable to conclude that OmniPro estimations for amino acid and protein can be reduced to 90%, or to conclude that OmniPro over estimates these requirements in this period. The live performance obtained with one feed during a specific period influences the performance of the subsequent period of feeding, and also the final carcass traits in a way that cannot be easily predicted (Gous, 1998, 2001). Therefore, the optimum level of amino acids has to be considered for the whole period of broiler growth. However, based on results of this trial presented herein it is clear that at least 3.5 percentage points of crude protein could be reduced in the starter diet, and around 1.5 percentage points in the grower and finisher diets from the values estimated by the OmniPro model. Since a one percent reduction in dietary crude protein decreases nitrogen excretion by 10% (Cauwenberghe and Burnham, 2001), any reduction in protein content in the diet can have a big environmental impact. The final protein content of the OmniPro diets without a minimum protein requirement was not lower than those levels already estimated to be the minimum necessary to guarantee maximum performance in broiler chickens (Si *et al*., 2000; Jiang *et al*., 2001).

Carcass characteristics: Although significant differences in dressing percentage were observed among dietary treatments they followed no consistent pattern related to amino acid level or the presence or absence of a minimum CP requirement (Table 4). The maximum breast meat yield was observed either with full protein OmniPro estimated diets or any reduced crude protein diet that kept the OmniPro estimated amino acids above 100%. Abdominal fat was reduced as the dietary amino acid level increased with the lowest abdominal fat observed in chickens fed reduced protein diets with 115% of OmniPro estimated amino acid levels.

The OmniPro model amino acid estimations are based on the theoretical ideas proposed by Hurwitz *et al*. (1978). The model calculates overall amino acid requirements as a sum of maintenance and weight gain for body tissues and feathers, divided by the efficiency of absorption. These daily amino acid needs are divided by the independently estimated energy requirements to estimate amino acid to calorie ratios. These ratios, multiplied by the energy concentration of the diet, results in the amino acid concentration in the diet, either as digestible or total amino acids. The initial model was tested in broiler chickens (Hurwitz *et al*., 1980; Jackson, 1987) as well as in growing turkeys (Hurwitz *et al*., 1983a, b). The initial model did not estimate a real requirement for protein. Nevertheless, the previous evaluations indicated lower estimations of protein than those usually recommended at that time NRC (1974, 1984) for growing chickens. A re-evaluation of these estimations for protein could be necessary.

Conclusion: it appears that a reduction in the crude protein content estimated by OmniPro® II does not affect live performance or carcass composition if the amino acid levels are adequate. This is based upon the use of corn-soybean meal based diets with lysine and methionine supplements. As more amino acid supplements become available, a possible reduction in CP associated with further amino acid additions might alter this conclusion.

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