Precise amino acid availability values key

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POULTRY feeding has changed over the years. In early formulation of rations for the integrated poultry industry, the dominant ingredients included a grain or starch source (primarily corn), a vegetable protein source (soybean meal), an animal protein source (fish meal), supplemental fats and oils, vitamins and minerals. These ingredients were of high nutritive value, readily available and reasonably priced, with fairly consistent values.

Formulation was based upon crude protein values and acknowledged the total and available amino acid values that were known. Because of the availability and cost of these ingredients, it was possible to over-formulate protein levels in order to supply enough available amino acids to maximize the performance of birds. The extra cost was minimal, environmental effects were not a consideration and profits were good.

However, in today's production environment, record-high prices for corn, soybean meal and fish meal have put limits on formulations like never before. Fish meal has disappeared from broiler formulation due to cost increases. The use of blended animal proteins (BAP) or commodity animal proteins supplemented with synthetic amino acids has replaced fish meal in poultry diets.

Maximum performance is still the primary goal; however, over-formulation is too expensive and environmentally unacceptable.

For many, the use of available amino acids is a way to formulate poultry diets and is more effective and more economical than formulating diets using crude protein or total amino acids.

Rostagno et al. (1995) showed that using available amino acid formulations in broiler rations allowed for a lower crude protein value than formulations using total amino acids. In addition, this report showed that available amino acid formulations allowed for the use of effective lower-cost ingredients, which lowered the cost of the finished ration.

Variability

The crude protein levels in major ingredients have variability issues that can cause problems in formulations.

In 2011, Evonik reported that soybean meal contained an average of 46.33% crude protein, with a range of 43.07-49.34% and a coefficient of variation (CV) of 2.09%. Corn had an average 7.46% crude protein with a range of 5.98-9.63% and a CV of 8.31%. Ruminant meat and bone meal (MBM) received over two weeks in September 2012 by H.J. Baker & Bro. Inc. had an average crude protein value of 50.28%, with a range of 42.41-67.18% and a CV of 7.01%.

BAP products can reduce this variability by 3.85 times, i.e., CV of 6.95% for MBM versus CV of 1.82% for BAP produced at the same mills over the same period (Table 1). Similar levels of variability are also found in the amino acid values for the major ingredients (Table 2).

The same can be said for available amino acid values, which are determined by developing digestibility coefficients through cecectomized rooster trials and apparent ileal digestibility studies in chicks for major ingredients (Sibbald, 1979; Garcia et al., 2007).

Tahir and Pesti (2012) reported that the total amino acid concentration may affect available amino acids.

So, how credible are available amino acid coefficients for BAP products?

Research

The solution stretched across companies, disciplines and universities. To develop a credible available amino acid database, a plan was developed to review publicly available research, conduct *in vitro* available amino acid research and, then, confirm predicted values through *in vivo* research using both cecectomized roosters and apparent ileal available amino acid studies in chicks.

Phase 1 was to contract with Dr. Alex Corzo at Mississippi State University to conduct a literature review that collected published available amino acid coefficients and determined means and 95% confidence levels for reported values (Table 3).

Published data from Ajinomoto Heartland LLC were also evaluated, as were data from Evonik Industries on samples in which available amino acid values were determined using a FOSS analyzer with Evonik's algorithms.

Phase 2 was to utilize Novus International's IDEA system of enzymatic available amino acid determination. Ingredient samples were collected for 12 weeks at Ft. Smith, Ark., and assayed

1. Variability in components of broiler rations

	SBM[1]	Corn[1]	MBM[2]	BAP[3]
Avg., %	46.33	7.46	50.28	57.97
CV, %	2.09	8.31	7.01	1.82
Min.	43.07	5.98	42.41	55.68
Max.	49.34	9.63	67.18	60.43
Number of samples	484	598	174	154

[1]SBM = soybean meal; "2011 Crop Year Report," Evonik Corp., AMINONIR and AMINOLab services.
[2]Ruminant MBM received over two weeks at four H.J. Baker & Bro. plants.
[3]BAP produced over two weeks at four H.J. Baker & Bro. plants.

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2. Variability (%) of limiting amino acids in MBM versus BAP

	MBM			BAP		
	Lysine	Methionine	Threonine	Lysine	Methionine	Threonine
Avg.	2.53	0.67	1.59	3.01	0.67	2.08
Std. dev.	0.31	0.11	0.18	0.15	0.03	0.08
CV, %	12.16	16.75	11.08	4.94	5.18	3.91
Samples	168	162	156	104	102	108

3a. Amino acid digestibility coefficients

Amino acid	Source*	MBM (PK)	MBM (NPK)	MBM (pork)	Poultry meal (pet)
Lysine	Lit.	83.50 [9.35]	77.80 [18.45]	83.50 [9.35]	83.20 [8.00]
	IDEA	78.10 (8.28)	77.40 (7.84)	75.78 (11.67)	NA
Methionine	Lit.	87.70 [7.55]	81.60 [22.45]	87.70 [7.55]	89.20 [4.55]
	IDEA	82.40 (6.04)	81.70 (5.40)	80.83 (7.95)	NA
Cysteine	Lit.	66.70 [11.0]	54.80 [28.80]	66.70 [11.00]	69.20 [24.85]
	IDEA	58.70 (10.53)	57.60 (9.22)	56.16 (13.54)	NA
Threonine	Lit.	82.20 [9.25]	76.50 [14.75]	82.20 [9.25]	83.00 [6.60]
	IDEA	79.60 (5.72)	79.00 (5.07)	82.20 (7.14)	NA
Tryptophan	Lit.	79.10 [24.65]	79.10 [13.40]	79.10 [24.65]	81.10 [14.80]
	IDEA	88.90 (2.22)	88.70 (2.10)	88.27 (3.12)	NA
Arginine	Lit.	86.20 [16.20]	82.70 [11.80]	86.20 [16.20]	88.50 [6.15]
	IDEA	86.32 (2.83)	86.00 (2.29)	85.76 (3.32)	NA
Isoleucine	Lit.	85.70 [7.10]	81.80 [15.90]	85.70 [7.10]	87.20 [6.40]
	IDEA	83.20 (5.56)	82.60 (5.03)	81.72 (7.42)	NA
Valine	Lit.	84.80 [8.55]	80.30 [19.55]	84.80 [8.55]	85.40 [6.75]
	IDEA	81.28 (5.82)	80.60 (4.71)	80.12 (6.83)	NA
Leucine	Lit.	86.10 [11.7]	82.40 [14.85]	86.10 [11.70]	85.30 [22.00]
	IDEA	84.50 (5.10)	83.90 (4.55)	83.18 (6.70)	NA
Histidine	Lit.	NA	NA	NA	NA
	IDEA	76.09 (6.20)	75.30 (5.20)	74.86 (7.28)	NA
Phenylalanine	Lit.	NA	NA	NA	NA
	IDEA	87.13 (4.01)	86.60 (3.24)	86.33 (4.71)	NA

*Lit. values [95% confidence interval] are from a published literature review by A. Corzo. IDEA values (standard deviation) are from Novus International's IDEA Assay. NA = not applicable.

3b. Amino acid digestibility coefficients

Amino acid	Source*	Poultry meal	Feather meal	Blood meal	Fish meal
Lysine	Lit.	76.30 [11.75]	65.20 [22.65]	87.80 [12.50]	86.80 [12.00]
	IDEA	53.20 (8.23)	83.50 (5.98)	NA	NA
Methionine	Lit.	81.10 [18.45]	73.30 [20.50]	90.90 [10.80]	90.80 [13.10]
	IDEA	66.00 (5.01)	86.20 (4.57)	NA	NA
Cysteine	Lit.	61.90 [22.60]	60.60 [25.15]	80.50 [14.25]	71.20 [23.20]
	IDEA	31.30 (8.16)	65.40 (8.06)	NA	NA
Threonine	Lit.	75.80 [12.45]	72.50 [18.15]	88.20 [12.50]	84.30 [19.60]
	IDEA	64.30 (4.62)	83.20 (4.35)	NA	NA
Tryptophan	Lit.	78.30 [13.85]	81.40 [20.20]	89.30 [16.85]	83.30 [19.20]
	IDEA	82.20 (2.19)	90.30 (1.61)	NA	NA
Arginine	Lit.	85.20 [10.65]	82.60 [13.60]	88.70 [11.90]	87.90 [10.70]
	IDEA	80.05 (1.62)	88.12 (2.28)	NA	NA
Isoleucine	Lit.	81.70 [14.65]	85.40 [11.35]	82.60 [14.80]	87.50 [11.95]
	IDEA	67.80 (4.80)	86.70 (4.16)	NA	NA
Valine	Lit.	79.80 [14.60]	81.50 [13.55]	88.60 [14.80]	87.80 [13.30]
	IDEA	68.38 (3.32)	84.98 (4.69)	NA	NA
Leucine	Lit.	80.80 [12.80]	81.70 [13.35]	89.80 [14.85]	87.90 [12.25]
	IDEA	70.70 (4.21)	87.70 (3.85)	NA	NA
Histidine	Lit.	NA	NA	NA	NA
	IDEA	62.35 (3.54)	80.04 (4.99)	NA	NA
Phenylalanine	Lit.	NA	NA	NA	NA
	IDEA	78.24 (2.29)	89.68 (3.23)	NA	NA

*Lit. values [95% confidence interval] are from a published literature review by A. Corzo. IDEA values (standard deviation) are from Novus International's IDEA Assay. NA = not applicable.

4. Average predicted available amino acids minus true available amino acids of BAP (%)

	Difference
Lysine	0.01
Methionine	-0.05
Cysteine	-0.25
Threonine	-0.13
Phenylalanine	-0.20
Tryptophan	0.00
Valine	-0.38
Isoleucine	-0.18
Leucine	-0.29
Arginine	-0.23
Histidine	-0.10

5. Total amino acids of BAP

	% total	% predicted total
Lysine	3.28	2.91
Methionine	0.71	0.62
Cysteine	1.31	1.01
Threonine	2.13	1.87
Phenylalanine	2.20	1.97
Tryptophan	0.36	0.36
Valine	3.12	2.65
Isoleucine	2.03	1.76
Leucine	3.97	3.49
Arginine	3.95	3.53
Histidine	1.23	0.86

Source: University of Missouri-Columbia.

6. BAP, % available amino acids

	True, %	Predicted, %
Lysine	2.46	2.33
Methionine	0.60	0.50
Cysteine	0.94	0.57
Threonine	1.75	1.40
Phenylalanine	1.90	1.60
Tryptophan	0.34	0.28
Valine	2.65	2.12
Isoleucine	1.74	1.46
Leucine	3.38	2.85
Arginine	3.25	2.92
Histidine	1.01	0.61

Source: C.M. Parsons, University of Illinois.

for available amino acids, and the averages and standard deviations were determined.

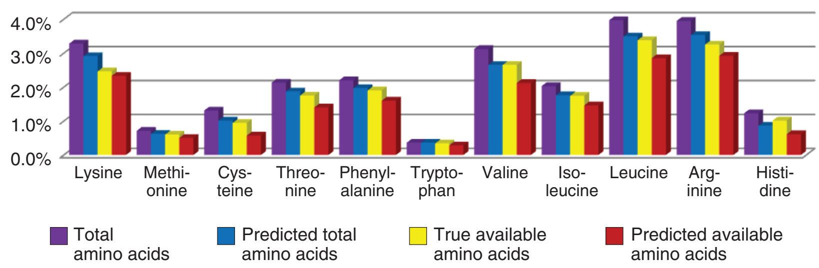
Evaluation of the collected information resulted in available amino acid coefficients that could then be placed into a matrix in the Brill Formulation System. Using this matrix, available amino acid values were predicted for BAP products. Having accurate available amino acid values for the BAP products allows rations to be formulated to meet available amino acid requirements without the expense of over-formulation to meet these requirements, thus lowering the cost.

Phase 3 was to confirm the predicted available amino acid values by *in vivo* evaluation. Two programs were set up to determine actual available amino acid values in BAP products.

The first is a continuing program to establish a database of available amino acid values for different BAP products with enough sample numbers to provide confidence in the results.

In this program, available amino acid tests on cecectomized roosters at the University of Illinois will be conducted under the supervision of Dr. Carl Parsons. Five samples will be tested initially, and one sample will become the standard.

Total and true available amino acid values versus predicted and true available amino acid values



The standard will be tested with four additional samples every three months. Different BAP products will be tested to evaluate the effects of different amino acid levels and ingredient combinations on the accuracy of the predicted available amino acid.

The second program will be an evaluation of apparent ileal available amino acids (AIAAA) in animal protein blends for broilers at 21 and 49 days of age. It will be conducted at the U.S. Department of Agriculture-Agricultural Research Service's Poultry Research Unit at Mississippi State, Miss., under the supervision of Drs. Elizabeth Kim and Kelley Wamsley.

The trial will evaluate eight BAP products with eight replications. AIAAA of all eight treatments will be determined for chicks at 21 and 49 days of age. This will also allow for the determination of if there are significant differences in the available amino acid values for different ages of chicks.

Previous research from this lab reported that AIAAA of BAP was significantly different for broilers at 21 days versus 42 days of age, and these differences warrant the need for further investigation (Kim and Corzo, 2012). These tests will be conducted this spring.

Rooster testing

Nine different blends have been tested in cecectomized roosters. The results indicate that predicted values are very close to live animal (true) results, although, generally, they were slightly lower (Table 4).

Some anomalies have occurred that replication should clarify. Available amino acid values for valine, leucine and cysteine show the greatest difference between actual and predicted values. Tables 5 and 6 and the Figure give examples of the data reported from these trials.

As additional data become available, adjustments will be made in the formulation matrix to more accurately predict actual results.

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