Calculating the Costs of Amino Acid Supplementation

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Take-Home Message

This study showed how using different database values for digestible amino acid contents influences ingredient usage and feed costs for example broiler diets with recent (2012) ingredient costs from the USA. A series of feeds were formulated to compare results from using two commercial ingredient composition databases: Ajinomoto Heartland Inc. (AHI, rooster assay values) and Evonik Industries (Evonik, chick assay values). The ingredient composition matrix was based on NRC (1994) tables except for digestible amino acids and protein. Requirements were for broiler starter, grower and finisher diets and are the authors' estimates for example purposes only diets. Formula costs were higher using the Evonik digestible amino acid values, $8.01, $8.08 and $8.41 for the starter, grower and finisher diets, respectively (about 2.5%). Differences in formulation costs were due to higher levels of supplemental amino acids, soybean meal and fat when using the Evonik database. The shadow price of wheat in the broiler finisher diet was $229.5/ton using AHI values but only $220.71 with Evonik digestible amino acid values. Not knowing the digestible amino acid levels in feed ingredients or choosing inappropriate digestible amino acid values may result (at least) in inefficiencies of approximately $8/ton of finished feed for broilers. Differences in feed cost from using the different digestibility values can give an estimate of potential savings (costs) from using a particular database versus the other. The cost difference could be used to demonstrate the magnitude of research monies that should be dedicated to most accurately estimating amino acid digestibility values, many millions of dollars!

Introduction

Tahir and Pesti (2012) published a study comparing the results of feed formulation models based on two different analytical approaches to determine amino acid digestibility. They used breeding company recommendations for digestible amino acid requirements. Interestingly, the breeding companies do not specify which feed ingredient values correspond to their stated requirements. Using the different databases resulted in differences of $1/ton for a turkey finisher, but $8/ton for a turkey starter. Broiler diets were intermediate. In the study presented here we update and extend those results with prices more typical of 2012 and requirements and ingredient compositions more similar to what we estimate is being used during 2012-2013.

Poultry and swine feed formulation was based on the total amino acids (AA) in ingredients for most of the 20th century (NRC 1994). Digestible amino acids are determined in animal assays as the product of digestion and absorption (Han and Parsons, 1990; Lemme et al., 2004). To minimize overfeeding, digestible amino acids are now generally used in place of total amino acids (Albino, et al., 1992; Green, 1986; Jolly, 1989; Rostagno, et al., 1995). Digestible amino

acid formulation has been shown to increase performance in broilers (Fernandez, et al., 1995; Rostagno, et al., 1995), lowering costs.

There are two competing schools of thought on the best model to use for determining digestible amino acids for poultry: Ajinomoto Heartland Inc. (AHI) values are based on rooster assays and the Evonik Industries (Evonik) values are based on chick assays (Fernandez and Parsons, 1996; Firman, 1992; Huang, et al., 2000; Johns, et al., 1986; Lemme, et al., 2001; Parsons, 1986; Rostagno, et al., 1995; Sibbald, 1987). Amino acid digestibility values determined with roosters are widely used in feed formulation for broilers, laying hens and turkeys (NRC, 1994).

Tahir and Pesti (2010) showed that the amino acid digestibility values from the different methods are clearly not interchangeable. They observed that digestible amino acids (% of diets) averaged 14.4% higher in the rooster than chick assays across 20 common poultry feed ingredients. Wang (1996) also observed that the rooster digestibility assay might have overestimated the bioavailability of TSAA for chick growth.

The questions addressed here are 1) how different amino acid digestibility database values influence ingredient usage and feed costs for broiler starter, grower and finisher diets with recent ingredient costs from the USA, and 2) the relative values of wheat in a broiler finisher diet with digestibility values from the two databases. This analysis using the different digestibility values can give an estimate of potential savings (costs) from using particular values but does not address potential response differences from feeding the different diets. The cost difference may be used to demonstrate the magnitude and importance of research monies that should be dedicated to accurately estimating amino acid digestibility values.

Materials and Methods

A series of feeds were formulated with values from Ajinomoto Heartland Inc. (AHI; rooster) and Evonik Industries [Evonik; chick) databases. A matrix for formulating feeds was compiled in Windows User-Friendly Feed Formulation (WUFFDA) from several sources: 1) the ingredient composition was from the NRC (1994) ingredient composition table except for digestible amino acids and crude protein levels; 2) the digestible amino acid values were compiled from two commercial companies' databases: Evonik Aminodat 4.0; http://www.aminodat.com and AHI; http://aaa.lysine.com/AATable/Ingredients.aspx; Table 1 accessed 08/06/2013. Costs were estimated from several sources for an American producer during 2012 (Table 1); 3) Digestible amino acid requirements were from an American broiler producer. Microsoft Excel version 1.2 was used for formulation and sensitivity analysis implemented with Windows User-Friendly Feed Formulation (WUFFDA). Values for "as-is" amino acid concentrations and digestibilities were used in the formulations. Ingredients were chosen based on discussion with several formulating and allied industry nutritionists during the summer of 2013 (Tables 2 and 3).

Table 1. The feed formulation matrix used to compare digestible amino acid values from Evonik Industries (Evonik) and Ajinomoto Heartland, Inc. (AHI) databases. Wheat, DDGS and meat and bone meals were fixed at 5, 3.5 and 3% in the starter diet, 6, 4.5 and 4% in the grower diet and 10, 6.5 and 5% in the finisher diet, respectively.

	Cost $/ton	Min. %	Max. %	M.E. Kcal/g	Protein %	Ca %	a P %	dLYS %	dMET %	dTSAA %	dTHR %
Corn, Grain EVK	264	0	100	3.35	7.8	0.02	0.10	0.22	0.15	0.30	0.29
Corn, Grain AHI	264	0	100	3.35	8.4	0.02	0.10	0.22	0.15	0.32	0.27
SBM -48% EVK	421	0	100	2.44	47.8	0.27	0.24	2.60	0.59	1.14	1.57
SBM -48% AHI	421	0	100	2.44	48.72	0.27	0.24	2.77	0.61	1.26	1.68
Wheat EVK	250	10	10	2.80	11.5	0.05	0.11	0.29	0.16	0.41	0.30
Wheat AHI	250	10	10	2.80	14.1	0.05	0.11	0.34	0.19	0.50	0.33
DDGS EVK	261	6.5	6.5	2.48	26.1	0.17	0.41	0.57	0.43	0.80	0.71
DDGS AHI	261	6.5	6.5	2.48	26.87	0.17	0.41	0.60	0.47	0.85	0.72
Meat&Bone EVK	462	5	5	1.96	53.7	10.30	5.10	1.74	0.51	0.79	1.05
Meat&Bone AHI	462	5	5	1.96	52.7	10.30	5.10	2.29	1.22	1.66	2.97
DL-Methionine	3380	0	100	3.61	58.1	0	0	0	99	99	0
L-Lysine HCl	2160	0	100	2.81	95.8	0	0	78	0	0	0
L-Threonine	2410	0	100	3.15	73.5	0	0	0	0	0	98.5
Poultry Fat	768	0	100	8.20	0	0	0	0	0	0	0
Limestone	48	0	100	0.00	0	38	0	0	0	0	0
Defluor. Phos.	494	0	100	0.00	0	32	18	0	0	0	0
Common Salt	106	0.4	0.4	0.00	0	0.30	0	0	0	0	0
Vitamin Premix	3600	0.25	0.25	0.00	0	0	0	0	0	0	0
Mineral Premix	1000	0.09	0.09	0.00	0	0	0	0	0	0	0

Table 2. The feed formulation nutrient restriction used to compare amino acid digestibility databases.

		Starter		Grower		Finisher	
	Units	Min.	Max.	Min.	Max.	Min.	Max.
M.E.	Kcal/g	3.00	100	3.07	100	3.12	100
Protein	%	22.40	100	20.15	100	18.14	100
Calcium	%	0.90	100	0.80	100	0.70	100
Avail. Phos.	%	0.45	100	0.40	100	0.35	100
dLYS	%	1.20	100	1.06	100	0.94	100
dMET	%	0.58	100	0.52	100	0.46	100
dTSAA	%	0.90	100	0.81	100	0.72	100
dTHR	%	0.80	100	0.74	100	0.67	100

Results and Discussion

The coefficient of determination (R^2) between the critical amino acids in corn, soybean meal, wheat and DDGS of >0.998 is quite remarkable (Figure 1). The slope of the line shows that the AHI (rooster) values are about 7% higher for these amino acids and ingredients. Including the values for meat and bone meal decreased the R^2 values from >0.998 to ~0.731. The exceptionally poor agreement for meat and bone meal is also remarkable and suggests that either there were big differences in the samples assayed with the different methods, or something about the meat and bone meal particularly inhibits either amino acid absorption or digestion when high concentrations are fed to chicks. Perhaps the high concentrations of Ca or P are having this effect in chicks but not roosters.

Formula costs were higher using the Evonik digestible amino acid values, ranging from $8.01/ton for the broiler starter to $8.41/ton for the broiler finisher (Table 3). The broiler starter and finisher diets were $6.2 and $2.6/ton higher using the Evonik digestible amino acid values in the earlier study (Tahir and Pesti, 2012). Cost differences were due to higher levels of supplemental amino acids, soybean meal and fat when using the Evonik database. Digestibility values of standard and alternative ingredients may also influence the values of alternative ingredients as evidenced by their shadow prices (Figure 2). The shadow prices of wheat and corresponding usage levels demonstrate the magnitude of such differences. In this case, about $9/ton, almost a 4% difference.

Tahir and Pesti (2012) suggested: "Differences in feed costs from using the different digestibility values can give an estimate of potential savings (costs) from using a particular database. The cost difference may be used to demonstrate the magnitude of research monies that should be dedicated to most accurately estimating amino acid digestibility values". Their study found about $4/ton differences in broiler feed, approximately a $160,000,000 per year difference from using one set of values versus the others for the American broiler industry. In Table 3 we show approximately an $8/ton difference using what we think are more appropriate requirements and ingredient choices. The cost and potential savings from using the right values would seem to indicate that a very serious evaluation by the producers themselves could have a very high return on investment.

Table 3. Least-costs linear programming results of solving the matrix in Table 1 and restrictions in Table 2.

		Starter		Grower		Finisher	
		Evonik	AHI	Evonik	AHI	Evonik	AHI
	Feed Cost	353.86	345.82	343.80	335.72	334.82	326.41
	$/ton	%	%	%	%	%	%
Corn, Grain	264	52.87	54.91	57.62	59.61	57.94	60.09
SBM -48%	421	30.70	29.11	23.28	21.74	15.80	14.14
Wheat	250	5.00	5.00	6.00	6.00	10.00	10.00
DDGS	261	3.50	3.50	4.50	4.50	6.50	6.50
Meat+Bone	462	3.00	3.00	4.00	4.00	5.00	5.00
DL-Methionine	3380	0.32	0.26	0.28	0.22	0.24	0.17
L-Lysine HCL	2160	0.25	0.21	0.28	0.24	0.32	0.29
L-Threonine	2410	0.09	0.03	0.12	0.04	0.13	0.04
Poultry Fat	768	2.10	1.81	2.34	2.06	2.84	2.52
Limestone	48	0.58	0.58	0.53	0.53	0.50	0.50
Defluor. Phos.	494	0.84	0.85	0.32	0.33	0.00	0.00
Common Salt	106	0.40	0.40	0.40	0.40	0.40	0.40
Vitamin Premix	9060	0.25	0.25	0.25	0.25	0.25	0.25
Mineral Premix	2092	0.09	0.09	0.09	0.09	0.09	0.09
M.E.	Kcal/g	3.00	3.00	3.07	3.07	3.12	3.12
Protein	%	22.40	22.40	20.15	20.15	18.14	18.14
Calcium	%	0.90	0.90	0.80	0.80	0.78	0.77
Avail. Phos.	%	0.45	0.45	0.40	0.40	0.39	0.39
LYS	%	1.20	1.20	1.06	1.06	0.94	0.94
MET	%	0.62	0.58	0.55	0.52	0.48	0.46
CYS	%	0.29	0.32	0.27	0.30	0.24	0.27
TSAA	%	0.90	0.90	0.81	0.82	0.72	0.73
THR	%	0.80	0.80	0.74	0.74	0.67	0.67
TRP	%	0.22	0.22	0.18	0.18	0.15	0.15
VAL	%	0.91	0.92	0.81	0.82	0.73	0.73

Figure 1. A comparison of the digestible amino acids in corn, soybean meal, wheat and distillers dried grains with solubles from the Ajinomoto Heartland, Inc. (AHI) and Evonik Industries (Evonik) databases. Including meat and bone meal decreased the R^2 value to 0.731.

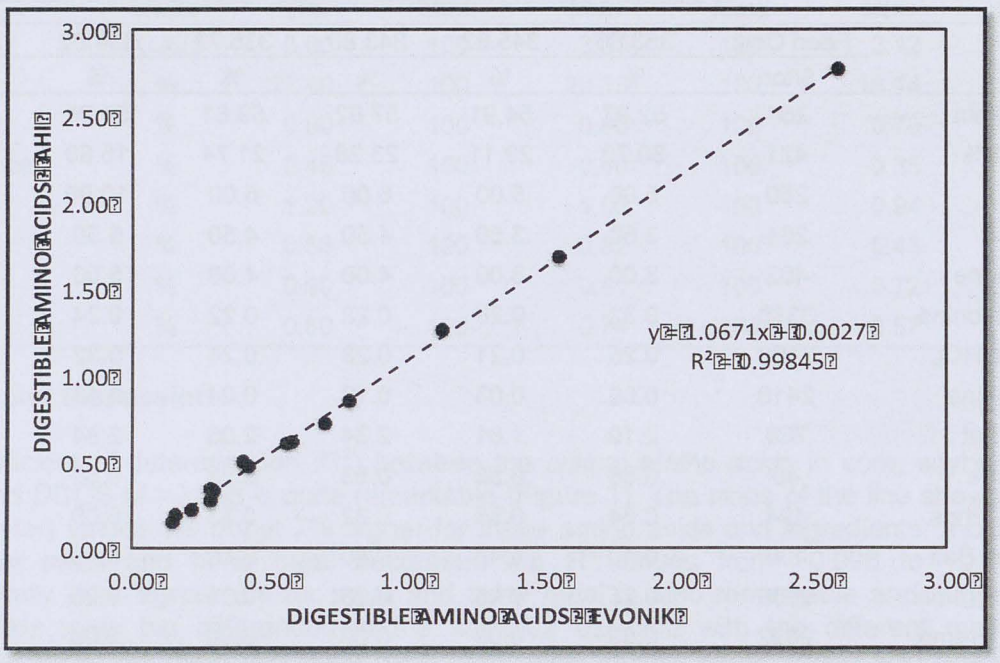
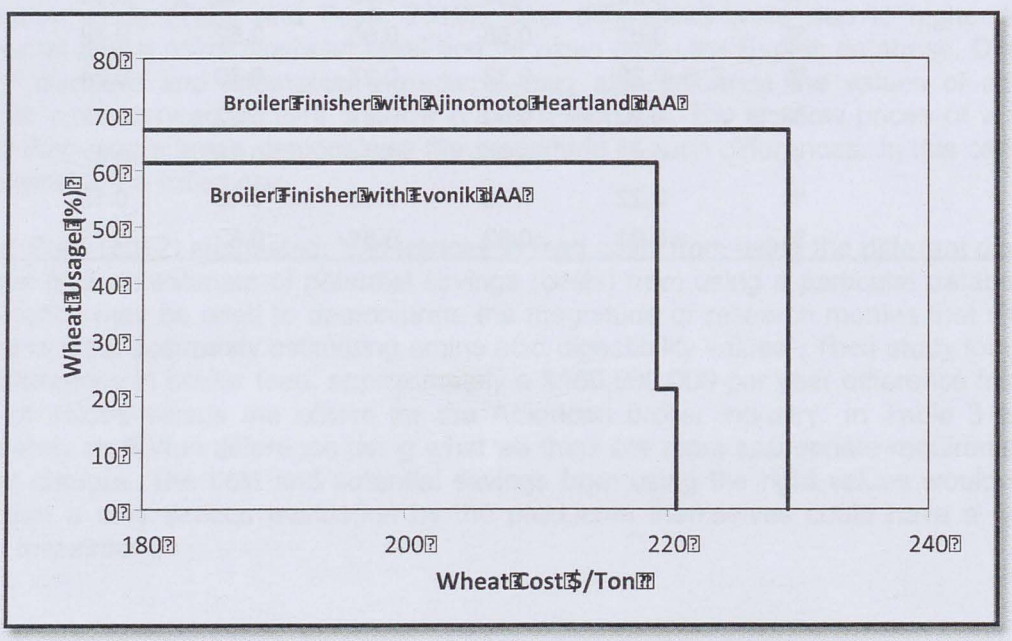


Figure 2. Parametric cost ranging of wheat in a broiler finisher diet (Tables 1 and 2) based on corn, soybean meal and 10% DDGS. Shadow prices are $229.25 for the Ajinomoto Heartland, Inc. (AHI) dAA values and $220.71 for the Evonik Industries (Evonik) dAA values.



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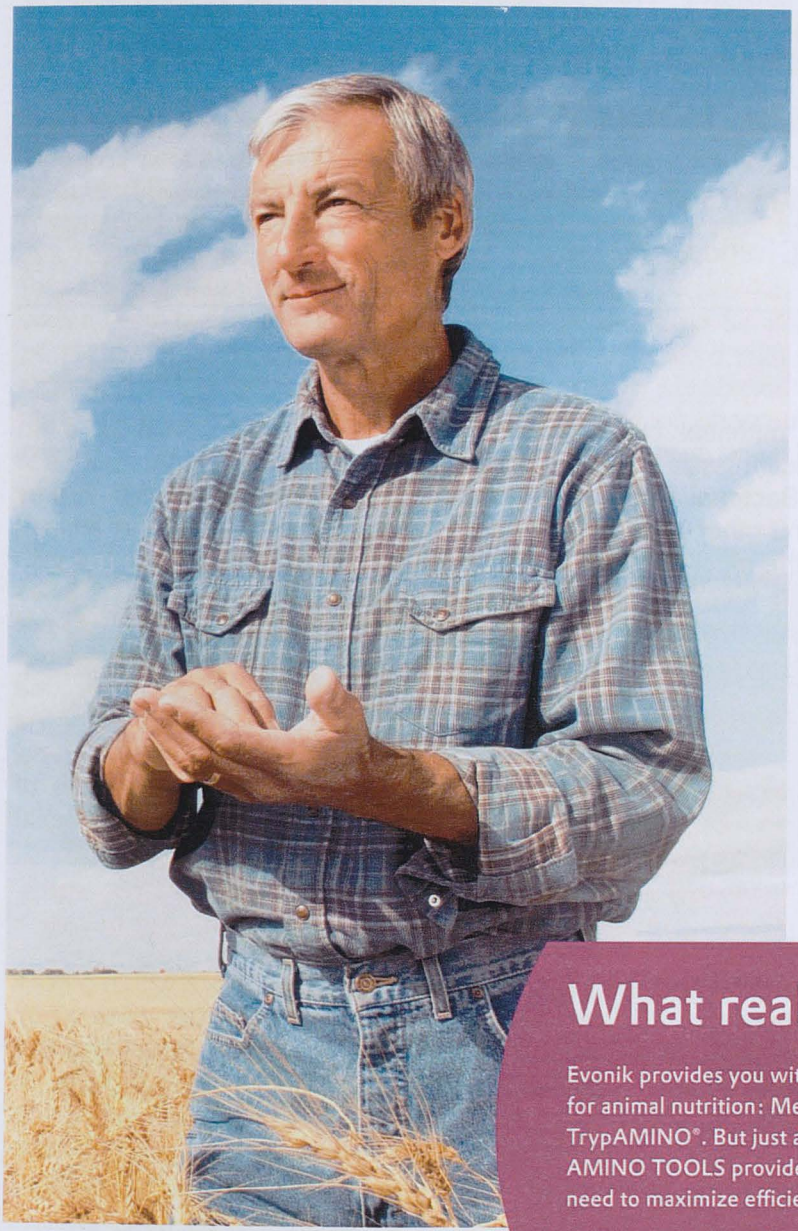

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