Determination of Ileal Digestibility of Amino Acids from Feed Ingredients for Laying Hens and Broilers

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Introduction

In order to effectively use corn, soybean meal (SBM), meat and bone meal, DDGS, wheat middling, and bakery byproducts, as well as other ingredients; nutritionists must have good nutritional information about these ingredients. Reliable nutritional information is not available for many feed ingredients, particularly direct information from laying hens.

Digestible amino acid values are considered by many to be the best measure of the amino acid value of ingredients. Unfortunately the amount of digestible amino acid data that is available, particularly for some ingredients, is not very large and so the data may be suspect. For example, primary digestible amino acid coefficients published by the amino acid suppliers vary to some degree, in part due to the inherent differences in experimental methodologies. Commercial nutritionists, therefore, find it difficult to make the switch to using digestible amino acid values so that they can efficiently use alternative feed ingredients.

Although there have been published data on amino acid digestibility of some feed ingredients in poultry (Adedokun et al., 2007a,b, 2008), there is the need to increase the available information in the database. This would undoubtedly increase the reliability of the data as well as the confidence level of commercial nutritionists in using this information in diet formulation. Therefore, the objective of this research was to continue to build the much needed database of feed ingredients for poultry, especially laying hens and broilers.

Materials and Methods

A total of 24 (3 corns, 3 SBM, 5 DDGS, 7 MBM, 5 bakery products, and 1 wheat middling) feed ingredients were evaluated for apparent and standardized ileal amino acid digestibility. Basal endogenous amino acid (EAA) losses were corrected after determination of endogenous loss after feeding of a nitrogen-free diet. Broilers were raised in cages from d 0 to 16 on a standard broiler starter diet after which they were randomized to treatments using a randomized complete design. There were 6 replicate cages of 8 birds/cage per dietary treatment. Each feed ingredient was the sole source of amino acid in each semi-purified diet which was fed for 5 days. All diets were formulated to 20% crude protein (CP). All the 24 feed ingredients were fed to broiler chickens. Meat and bone meal, MBM, (7), DDGS (5), and bakery products (5) were fed to young laying hens (30-wk of age Hyline W36) while corn (3), SBM (3), and wheat middling (1) were

fed to the relatively older laying hens (50 wk of age Hyline W36). Correction for ileal endogenous amino acid losses in broiler studies were done using values generated from broilers fed a nitrogen-free diet and similar values from laying hens were used to standardized ileal apparent AA digestibility in laying hens. The procedure, including diet formulation and calculations, employed in these studies were as reported by Adedokun et al. (2007a,b, 2008).

To date, analyses is complete for all MBM and DDGS samples, with the final amino acid analyses remaining for samples from birds fed corn, SBM, bakery byproducts, and wheat middlings. Notably, the funding from Midwest Poultry Consortium was enough to conduct the laying hen portion of the study. With additional analytical contributions from Evonik Degussa, the study was expanded to include additional comparisons with broiler chickens fed the same diets/ingredients.

Results and Discussion

Result from these studies show that same feed ingredients (e.g. MBM) from different locations (or processing techniques) varied widely in digestibility. For broiler chickens, the range of apparent Met (73.5-85.7%), Lys (74.3-85.9%), and Thr (66.1-78.6%) digestibility varied widely. Similar trends were seen after standardization (Met, 76-88.4%; Lys, 76.6-88.3%, and Thr, 72.4-82.7%). Meat and bone meal sample 4 was generally the least digested while MBM3 and 7 were the most digested (based on AA digestibility) out of the 7 MBM samples in broilers and laying hens. Unlike in the MBM sample with huge variations in AA digestibility between samples, variations between DDGS sample both in the laying hens and broilers were minimal.

In comparisons between ingredient use between broilers and hens, considerable differences were noted. Generally, hens had 7.2%-units less CP digestibility of all DDGS samples. For MBM samples, 4 of the 7 had lower digestibilities of CP by hens when compared to broilers (7.4%-units on average). Adedokun et al. (2009) noted the standardized total amino acid digestibility values for laying hens were lower for corn, higher for meat and bone meal (only 1 used for this study), but not different for the remaining ingredients (2 DDGS samples, SBM, or canola meal) when compared with broilers.

In summary, AA digestibility values from these feed ingredients are high and can be a good source of AA for broilers and laying hens. However, there is the need to procure feed ingredients from a reliable and consistent source so as to minimized variability in birds' performance. Amino acid digestibility from these studies are similar to what has been previously reported by Adedokun et al. (2007b and 2008). Formulation on a digestible amino acid basis may reduce cost, reduce AA excretion, and increase flock uniformity and performance; but it is important to realize that data from a broiler database for ingredient digestibility may not be applicable to that of laying hens.

References

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Table 1. Comparison of laying hen vs broiler apparent dry matter digestibility and amino acid standardized ileal digestibility (% of amino acid or crude protein) for 5 different DDGS sources.[1]

	DDGS1			DDGS2			DDGS3			DDGS4			DDGS5		
	Hen	Broiler	SEM	Hen	Broiler	SEM	Hen	Broiler	SEM	Hen	Broiler	SEM	Hen	Broiler	SEM
DM	49.1	49.3	1.87	55.0	57.2	1.85	52.5	56.3	1.59	60.6	61.1	0.88	51.6	51.1	1.57
CP	71.0[b]	77.5[a]	1.48	69.7[b]	78.3[a]	1.71	67.1[b]	80.2[a]	2.03	73.7[b]	82.1[a]	0.65	71.2[b]	78.9[a]	1.30
Essential amino acids															
Arg	76.4	80.0	1.50	75.5[b]	81.3[a]	1.44	72.3[b]	82.8[a]	1.83	79.4[b]	85.7[a]	0.73	77.0[b]	82.2[a]	1.61
His	73.3	76.0	1.39	72.4[b]	77.1[a]	1.36	70.6[b]	78.8[a]	1.40	73.7[b]	80.4[a]	0.79	72.9[b]	78.7[a]	1.58
Iso	71.3	75.2	1.61	68.8[b]	75.0[a]	1.79	67.3[b]	78.4[a]	1.76	72.9[b]	81.0[a]	0.86	71.4[b]	77.0[a]	1.81
Leu	82.1[b]	86.4[a]	1.11	80.3[b]	85.8[a]	1.11	77.3[b]	86.6[a]	1.16	81.3[b]	88.6[a]	0.64	81.9[b]	87.1[a]	0.97
Lys	60.5	62.1	2.34	54.7	61.1	2.59	55.5[b]	68.0[a]	3.06	63.1[b]	70.1[a]	1.18	59.6	64.3	2.62
Met	80.5[b]	84.3[a]	1.21	77.6[b]	82.7[a]	1.38	73.9[b]	84.4[a]	1.75	81.3[b]	87.7[a]	0.67	80.1[b]	84.3[a]	1.27
TSAA	76.0[b]	81.0	1.43	73.0[b]	80.3[a]	1.50	68.7[b]	81.0[a]	1.59	74.9[b]	84.3[a]	0.98	74.2[b]	81.9[a]	1.47
Phe	79.6	82.1	1.31	78.4	82.1	1.25	76.5[b]	83.4[a]	1.38	80.4[b]	85.4[a]	0.74	79.6	82.8	1.43
Thr	66.6	69.5	1.80	65.1	70.1	1.88	61.4[b]	69.5[a]	1.84	67.9[b]	74.5[a]	1.02	66.7	71.5	2.13
Val	69.5[b]	75.2[a]	1.50	67.3[b]	75.5[a]	1.87	64.0[b]	77.2[a]	1.72	70.5[b]	80.3[a]	0.84	69.2[b]	76.9[a]	1.65
Non-essential amino acids															
Ala	80.2	83.3	1.13	78.9[b]	83.4[a]	1.12	77.0[b]	84.6[a]	1.13	80.5[b]	86.4[a]	0.63	80.0[b]	84.3[a]	1.11
Asp	67.8	69.4	1.76	66.2	71.1	1.82	63.9[b]	73.1[a]	1.88	69.1[b]	74.5[a]	0.99	67.6	71.5	1.99
Cys	71.5[b]	77.7[a]	1.60	68.3[b]	77.7[a]	1.88	64.7[b]	77.9[a]	1.59	68.7[b]	80.6[a]	1.28	68.5[b]	79.1[a]	1.81
Glu	82.3[b]	86.0[a]	1.16	80.8[b]	85.6[a]	1.07	76.8[b]	85.8[a]	1.23	81.8[b]	88.3[a]	0.65	81.8[b]	86.6[a]	1.09
Gly	68.1	70.2	1.61	66.9	71.5	1.79	64.8[b]	74.0[a]	1.71	70.0[b]	75.7[a]	0.90	67.9	72.0	1.85
Pro	75.8[b]	79.9[a]	1.36	73.4[b]	79.7[a]	1.38	71.1[b]	81.0[a]	1.34	73.7[b]	82.6[a]	0.87	74.3[b]	81.4[a]	1.52
Ser	73.9	77.7	1.46	72.4[b]	78.5[a]	1.50	69.2[b]	78.1[a]	1.43	74.6[b]	81.5[a]	0.95	73.5[b]	79.1[a]	1.78

[ab] Means within ingredient with no common superscripts are significantly different ($P \leq 0.05$).

[1] Means represent 6 replicates per strain (hens or broilers) with 6 or 8 birds per replicate for hens and broilers, respectively. Hens were 30-wk-old and broilers were 21 d-old.

Table 2. Comparison of laying hen vs broiler apparent dry matter digestibility and standardized ileal amino acid digestibility (% of amino acid or crude protein) for 5 different MBM sources.[1]

	MBM1			MBM2			MBM3			MBM4			MBM5		
	Hen	Broiler	SEM	Hen	Broiler	SEM	Hen	Broiler	SEM	Hen	Broiler	SEM	Hen	Broiler	SEM
DM	80.5[a]	75.3[b]	1.16	78.8	76.8	0.93	83.0	81.6	1.08	74.4	77.3	1.96	75.3	72.7	1.23
CP	78.8	78.0	2.90	72.6	77.9	2.19	80.1[b]	85.3[a]	1.35	63.9[b]	76.6[a]	2.07	71.2[b]	77.4[a]	1.66
Essential amino acids															
Arg	83.0	83.4	2.58	78.9	83.2	1.67	83.0[b]	88.4[a]	1.37	70.6[b]	82.0[a]	1.82	76.5[b]	82.9[a]	1.34
His	78.4	77.0	2.49	73.4	79.8	2.68	80.6[b]	88.2[a]	1.20	67.6[b]	76.8[a]	2.18	76.4[b]	82.9[a]	1.81
Iso	81.3	79.8	2.60	73.9	78.4	2.64	81.9[b]	86.8[a]	1.43	64.5[b]	75.9[a]	2.19	76.0	80.3	1.43
Leu	82.7	81.8	2.30	76.3	80.8	2.22	83.0[b]	87.9[a]	1.32	66.8[b]	77.9[a]	2.01	77.1[b]	81.7[a]	1.28
Lys	80.0	79.7	2.78	73.6	79.7	2.63	81.7[b]	87.2[a]	1.25	64.4[b]	76.6[a]	2.03	75.8[b]	81.8[a]	1.20
Met	81.4	80.7	2.46	73.0	79.0	2.98	83.5[b]	87.9[a]	1.25	64.2[b]	76.0[a]	2.13	78.1[b]	83.1[a]	1.22
TSAA	76.2	72.4	2.91	67.8	68.7	2.49	75.5	79.6	1.94	58.0[b]	69.9[a]	2.83	71.7	74.1	1.93
Phe	85.4	84.9	2.24	77.9	83.8	2.33	84.6[b]	90.3[a]	1.34	68.4[b]	80.2[a]	2.10	79.1[b]	83.3[a]	1.09
Thr	78.3	77.9	2.74	71.2	75.9	2.42	79.5[b]	84.9[a]	1.68	60.5[b]	74.0[a]	2.57	71.8[b]	77.1[a]	1.74
Val	81.3	80.6	2.47	74.8	79.9	2.28	81.8[b]	86.9[a]	1.40	65.7[b]	77.4[a]	2.05	75.8[b]	80.6[a]	1.32
Non-essential amino acids															
Ala	81.0	82.3	2.81	77.3[b]	83.2[a]	1.72	82.0[b]	88.2[a]	1.24	68.2[b]	81.1[a]	1.75	73.8[b]	81.9[a]	1.44
Asp	72.9	69.9	3.87	63.9	70.0	2.80	75.9[b]	80.9[a]	1.46	53.0[b]	67.1[a]	2.61	63.9	69.3	1.89
Cys	67.1	57.9	3.77	59.4	51.9	2.79	64.0	67.1	3.13	46.2	57.9	4.39	61.7	59.9	3.02
Glu	80.2	79.6	2.79	74.2	79.5	2.11	80.9[b]	86.3[a]	1.37	63.4[b]	76.8[a]	2.04	73.4[b]	79.6[a]	1.48
Gly	77.4	78.6	3.59	74.3[b]	81.1[a]	1.44	78.9[b]	85.4[a]	1.33	64.6[b]	79.9[a]	1.76	67.8[b]	77.2[a]	2.04
Pro	73.6	73.9	3.84	70.8[b]	76.8[a]	1.58	75.5[b]	82.0[a]	1.57	59.8[b]	75.9[a]	2.09	62.3[b]	71.7[a]	2.28
Ser	77.5	76.0	3.13	71.1	75.1	2.07	77.5[b]	83.2[a]	1.69	60.7[b]	74.4[a]	2.53	69.4	75.0	1.87

[ab] Means within ingredient with no common superscripts are significantly different ($P \leq 0.05$).

[1] Means represent 6 replicates per strain (hens or broilers) with 6 or 8 birds per replicate for hens and broilers, respectively. Hens were 30-wk-old and broilers were 21 d-old.

Table 3. Comparison of laying hen vs broiler apparent dry matter digestibility and standardized ileal amino acid digestibility (% of amino acid or crude protein) for 2 different MBM sources.[1]

	MBM6			MBM7		
	Hen	Broiler	SEM	Hen	Broiler	SEM
DM	81.6[a]	76.4[b]	0.72	81.9	80.9	0.78
CP	77.1	77.2	1.32	79.5[b]	85.1[a]	1.07
Essential amino acids						
Arg	82.3	82.5	1.13	83.5[b]	88.8[a]	1.36
His	76.3	76.8	1.38	80.4[b]	85.6[a]	0.92
Iso	78.9	77.9	1.43	82.4[b]	86.4[a]	1.13
Leu	79.8	79.5	1.30	83.4[b]	87.9[a]	1.06
Lys	80.6	82.9	1.50	83.2[b]	88.3[a]	1.04
Met	82.7	83.1	1.32	84.6[b]	88.4[a]	0.93
TSAA	68.4	64.2	1.87	74.3	76.8	1.48
Phe	85.1	85.3	1.19	87.4[b]	82.2[a]	1.05
Thr	72.8	72.4	1.74	77.6[b]	82.7[a]	1.15
Val	77.0	77.0	1.42	82.0[b]	87.1[a]	1.09
Non-essential amino acids						
Ala	82.0	84.2	1.03	82.7[b]	89.2[a]	1.11
Asp	64.5	64.7	1.71	74.1[b]	79.1[a]	1.07
Cys	49.3[a]	39.4[b]	2.91	64.5	64.8	2.13
Glu	78.1	78.5	1.24	80.8[b]	85.9[a]	1.10
Gly	79.8	82.5	1.03	79.7[b]	87.3[a]	1.15
Pro	75.5	76.8	1.29	75.3[b]	82.9[a]	1.29
Ser	72.1	81.5	1.64	75.9[b]	81.5[a]	1.26

[ab] Means within ingredient with no common superscripts are significantly different ($P \leq 0.05$).

[1] Means represent 6 replicates per strain (hens or broilers) with 6 or 8 birds per replicate for hens and broilers, respectively. Hens were 30-wk-old and broilers were 21 d-old.