Kansas Agricultural Experiment Station Research Reports

Volume 7
Issue 10 *Animal Feed and Pet Food Research Report* | Article 18

2021

Determining the Amino Acid Digestibility of Soybean Meal from Different Midwest Soybean Varieties Fed to Broilers

Kara M. Dunmire
Kansas State University, karadunmire@k-state.edu

Michaela B. Braun
Kansas State University, mbraun1@ksu.edu

Caitlin E. Evans
Kansas State University, caitlinevans@k-state.edu

See next page for additional authors

Recommended Citation

Dunmire, Kara M.; Braun, Michaela B.; Evans, Caitlin E.; Stark, Charles R.; and Paulk, Chad B. (2021) "Determining the Amino Acid Digestibility of Soybean Meal from Different Midwest Soybean Varieties Fed to Broilers," *Kansas Agricultural Experiment Station Research Reports*: Vol. 7: Iss. 10. https://doi.org/10.4148/2378-5977.8156

Funding Source
Appreciation is expressed to the Illinois Soybean Association for partial financial support of this study.

Authors
Kara M. Dunmire, Michaela B. Braun, Caitlin E. Evans, Charles R. Stark, and Chad B. Paulk

Determining the Amino Acid Digestibility of Soybean Meal from Different Midwest Soybean Varieties Fed to Broilers[1,2]

Kara M. Dunmire, Michaela B. Braun, Caitlin E. Evans, Charles R. Stark, and Chad B. Paulk

Summary

At hatch, 240 one-day old Cobb500 male broilers were placed in battery cages to determine soybean meal (SBM) apparent ileal digestibility (AID) of amino acids (AA). There were 6 broilers per cage and 10 replicates per treatment. A common corn-SBM crumble starter diet was fed from d 0 to 10 with experimental mash diets fed from d 10 to 18 with SBM as the only source of AA. Dietary treatments consisted of 1 of 4 soybean sources varying in quality determined by crude protein (CP) content and processed into SBM. Dietary treatments consisted of a commercially processed SBM with 47% CP (CSBM) or experimentally processed SBM with 42% CP (42SBM), 49% (49SBM), or 52% CP (52SBM). Two sources consisted of soybeans from a similar region and were processed either commercially (CSBM) or experimentally (49SBM) solvent extracted at Texas A&M University. Additional sources included a low quality (42SBM) and high-quality (52SBM) soybean, experimentally solvent extracted into SBM at a pilot-scale facility at Texas A&M University. Dietary treatments were dextrose and SBM-based, and consisted of 1 of 4 SBM sources included in diets formulated to 20% CP. On d 18, broilers were euthanized by CO_2 inhalation and ileal samples were collected for determination of AID of AA. Soybean meal processed from low, medium, and high CP soybeans resulted in increased concentrations of crude protein and indispensable AA. Individual SBM samples indicated that SBM with higher CP had lower NDF. Data were analyzed using the GLIMMIX procedure in SAS 9.4, with cage as the experimental unit, cage location as the blocking factor with Tukey-Kramer adjustment for multiple comparisons used. For soybeans grown in a similar region, broilers fed CSBM, processed conventionally, had increased ($P < 0.05$) AID of total AA, Arg, His, Lys, and Thr compared to 49SBM, processed experimentally. Increasing the CP content of SBM from 42SBM, and 49SBM, to 52SBM increased ($P < 0.05$) AID of total AA, Arg, His, Leu, Lys, Thr, and Val. Broilers fed CSBM, 49SBM, and 52SBM had increased ($P < 0.001$) Ile, Met, Phe, and Trp compared to broilers fed 42SBM. In conclusion, CSBM and 49SBM were sourced from a similar location but processed either commercially or experimentally, respectively. Commercially processed SBM had improved AID

[1] This study was completed in along with the following study; therefore, references are made to the following study: Dunmire, K. M.; Braun, M. B.; Evans, C. E.; Stark, C. R.; and Paulk, C. B. (2021) "Effect of soybean meal from different Midwest soybean varieties on growth performance of broilers," Kansas Agricultural Experiment Station Research Reports Vol. 7, Issue 10. https://newprairiepress.org/kaesrr/vol7/iss10/.

[2] Appreciation is expressed to the Illinois Soybean Association for partial financial support of this study.

AA compared to the experimentally processed SBM. Additionally, SBM with increasing concentrations of CP and AA had improved AID of AA.

Introduction

A shift in major issues affecting competition for soybean meal (SBM) usage in swine and poultry diets has occurred in recent years. Traditionally, SBM is added to livestock and poultry diets because it is an economical source of crude protein and essential amino acids (AA). In recent years, ingredient cost and availability has increased utilization of more economical crystalline amino acids and by-product ingredients. Therefore, it is essential to focus on optimizing SBM quality to maintain its competitive edge in livestock and poultry diets, and continue to find ways to reduce diet cost for producers. Selecting for soybean varieties that result in increased AA concentrations in SBM will provide an improvement in the feeding value of SBM. However, it is important to determine if there is a difference in the digestibility of those AA to further influence the feeding value of SBM. Therefore, the objective of this study was to determine the apparent ileal digestibility (AID) of AA for SBM varieties varying in CP content when fed to broilers.

Materials and Methods

The Institutional Animal Care and Use Committee at Kansas State University (Manhattan, KS) reviewed and approved the protocols used in this study. A total of 240 one-day old male broilers (Cobb 500, Cobb-Vantress, Siloam Springs, AR) were obtained and transported to the Kansas State University Poultry Facility (Manhattan, KS) to be used in an 18-d digestibility study. Broilers were placed in 1 of 2 Petersime batteries with 6 broilers per cage (dimensions, 38.0 × 13.0 in.), balanced by BW and provided a common corn, soybean meal crumble diet. On d 10, cages were randomly assigned to 1 of 4 dietary treatments within location block and balanced by BW with 10 replicates per treatment. Illumination was provided by fluorescent bulbs for the duration of the experiment. A HOBOware data logger was used to record temperature, relative humidity, and light intensity of the battery room. For the first 7 d, averages were 87.4°F, 61.3%, and 13.3 lum/ft^2, followed by 82.4°F, 71.5%, and 13.2 lum/ft^2 for the remainder of the experiment for temperature, relative humidity, and light intensity, respectively. Feed was provided *ad libitum* in a single pan feeder (capacity approximately 4.4 lb) per pen. Water was provided *ad libitum* through water troughs. A validation study was also completed to determine broiler growth performance using the same four SBM sources added to complete diets.[1]

Dietary treatments

Assay diets were dextrose and SBM-based and fed in meal form, formulated to supply 20% CP in the diet (Table 2). All diets used titanium dioxide as an indigestible marker. Dietary treatments consisted of 1 of 4 soybean sources varying in quality determined by crude protein (CP) content and processed into SBM. Two sources consisted of soybeans from a similar region and processed either commercially or experimentally solvent extracted at Texas A&M University. Additional sources included a low quality and high-quality soybean, experimentally solvent extracted into SBM at Texas A&M University. Therefore, dietary treatments consisted of a commercially-processed SBM with 47% CP (CSBM), or experimentally processed SBM with 42% CP (42SBM), 49% (49SBM), or 52% CP (52SBM).

Ileal collection

On d 18, broilers were euthanized by CO_2 inhalation and ileal samples were collected for AA analysis. Ileal contents were collected beginning 0.4-in. posterior to the Meckel's diverticulum and ending 0.4-in. prior to the ileocecal junction. Ileal samples were collected and pooled by pen. Composite samples were stored at -4°F prior to lyophilization. Samples were finely ground to pass through a 0.02-in. screen and sent to the University of Missouri Agricultural Experiment Station (Columbia, MO) for analysis.

Chemical analysis

Individual soybean meal and diet samples were analyzed for proximate analysis and complete AA profile,[3] available Lys,[4] protein solubility,[5] and trypsin inhibitor activity[6] (Table 1). Diets and ileal samples were analyzed for titanium dioxide[7] as an indigestible marker. Ileal contents were analyzed for dry matter and complete AA profile[3] for determination of AID of AA.

Calculations

Calculations for AID of AA were calculated using the following equation[8]:

$$AID_{AA}(\%) = \left[1 - \left(\frac{AA_{diet}}{AA_{digesta}}\right) \times \left(\frac{TiO_{2,digesta}}{TiO_{2,diet}}\right.\right] \times 100,$$

where $AA_{digesta}$ and AA_{diet} represent the AA concentrations (g/kg) in digesta and diet DM, respectively, and $TiO_{2,\ diet}$ and $TiO_{2,\ digesta}$ represent the digestible marker concentrations (g/kg) in diet and digesta DM, respectively (Table 3).

Statistical analysis

Data were analyzed using the GLIMMIX procedure in SAS v. 9.4 (SAS Inst., Cary, NC), with cage as the experimental unit, cage location as the blocking factor and adjusted using Tukey-Kramer multiple comparisons.

Results and Discussion

Individual soybean meal samples contained 46.9, 41.8, 49.1, and 51.8% CP and 2.97, 2.60, 3.09, and 3.21% Lys in the CSBM, 42SBM, 49SBM, and 52SBM, respectively (Table 1). The 49SBM was sourced from the same geographical region as the CSBM, therefore it was expected these would be similar in CP content. The 42SBM, 49SBM, and 52SBM were processed into soybean meal on a pilot scale crush facility at Texas A&M University. These samples had an increased DM compared to the CSBM. Therefore, the 49SBM and CSBM had similar CP and Lys when expressed on a DM basis.

---

[3] AOAC Official Method 982.30 E(a,b,c), chp. 45.3.05, 2006.

[4] AOAC Official Method 975.44, chp. 45.4.03, 2006.

[5] KOH method, J Anim Sci, 69:2918-2924, 1991.

[6] AACC Official Method 22-40, 2006.

[7] Myers, W. D., P. A. Ludden, V. Nayigihugu, B. W. Hess. 2004. Technical Note: A procedure for the preparation and quantitative analysis of samples for titanium dioxide, J. Anim. Sci., Volume 82, Issue 1, Pg 179–183, https://doi.org/10.2527/2004.821179x.

[8] Kong, C., & Adeola, O. (2014). Evaluation of amino acid and energy utilization in feedstuff for swine and poultry diets. Asian-Australasian Journal of Animal Sciences, 27(7), 917–925. https://doi.org/10.5713/ajas.2014.r.02.

Individual SBM samples contained 2.80, 2.43, 2.89, and 3.08% available Lys and 86.27, 74.30, 85.72, and 76.95% KOH protein solubility in the CSBM, 42SBM, 49SBM, and 52SBM, respectively. In addition, individual soybean meal samples contained 2.65, 0.71, 2.01, and 3.08 TIU/lb for trypsin inhibitor, respectively. Crude fat in individual soybean samples contained 1.6, 1.9, 1.6, and 1.8% in CSBM, 42SBM, 49SBM, and 52SBM, respectively. High CP soybean samples had lower NDF, where NDF was 12.0, 14.2, 7.8, and 8.2% for CSBM (46% CP), 42SBM, 49SBM, and 52SBM, respectively. Chemical analysis results for ADF were 6.7, 7.8, 6.8, and 6.9% for CSBM, 42SBM, 49SBM, and 52 SBM, respectively, where low CP soybean had higher ADF.

There was an overall treatment effect (P < 0001) for AID of total AA and all indispensable AA. For soybeans grown in a similar region, broilers fed CSBM, processed conventionally, had increased (P < 0.05) AID of total AA, Arg, His, Lys, and Thr compared to 49SBM, processed experimentally. There was no evidence of difference in total amino acid, indispensable AA, or dispensable AA digestibility in broilers fed the CSBM and 52SBM (Table 3). The AID of total AA, Arg, His, Lys, and Thr was greater (P < 0.001) in CSBM compared to 49 SBM. Soybean meal with increasing CP content from 42SBM, 49SBM, and 52SBM had increased (P < 0.001) AID of total AA, Arg, His, Leu, Lys, Thr, and Val. The AID of Ile, Met, Phe, and Trp decreased (P < 0.01) in broilers fed 42SBM compared to CSBM, 49SBM, and 52SBM.

In conclusion, soybean meal processed from low, medium, and high CP soybeans resulted in increased concentrations of crude protein and indispensable AA. Individual soybean samples indicated that soybeans with higher CP had lower NDF. Broilers fed conventionally processed soybean meal had improved amino acid digestibility compared to those fed experimentally processed soybean meal from similar sources. Soybean meal from high crude protein soybeans had increased digestibility of Arg, His, Ile, Leu, Lys, Thr, and Val compared to soybean meal from 42SBM and 49SBM when fed to 18-day old broilers. The increased AID of AA and increased AA content of high CP soybean meal resulted in an increase in digestible amino acid content provided by SBM.

Table 1. Chemical analysis of individual soybean varieties (as-is basis)[1,2,3]

Item, %	CSBM	42SBM	49SBM	52SBM
Dry matter	89.53	93.74	92.62	93.74
Crude protein	46.86	41.82	49.19	51.79
Crude fat	1.58	1.94	1.61	1.84
Crude fiber	3.85	5.91	3.60	3.41
ADF	6.68	7.75	6.83	6.93
NDF	12.03	14.24	7.83	8.24
Ash	6.89	6.37	6.93	6.82
Available Lys	2.80	2.43	2.89	3.08
Lys: crude protein	6.34	6.22	6.28	6.20
KOH solubility	86.27	74.30	85.72	76.95
Trypsin inhibitor, TIU/lb	2.651	0.711	2.013	3.079
Total AA	45.30	40.56	47.85	50.64
Indispensable AA				
Arg	3.25	2.79	3.42	3.67
His	1.20	1.10	1.28	1.33
Ile	2.23	2.00	2.35	2.48
Leu	3.55	3.19	3.75	3.98
Lys	2.97	2.60	3.09	3.21
Met	0.65	0.59	0.70	0.73
Phe	2.36	2.10	2.49	2.64
Thr	1.78	1.65	1.90	1.97
Trp	0.64	0.64	0.72	0.74
Val	2.31	2.09	2.45	2.56

[1]At hatch, 240 male broilers (Cobb 500, Cobb-Vantress, Siloam Springs, AR) were placed in battery cages with 6 broilers per cage and 10 replicates per treatment.
[2]Dietary treatments consisted of one of the following soybean meal (SBM) sources: control (47% CP; CSBM), a low quality SBM (42% CP; 42SBM), a medium quality SBM (49% CP; 49SBM), and a high quality SBM (52% CP; 52SBM) where 42SBM, 49SBM, and 52SBM soybeans were processed into SBM using a pilot scale facility at Texas A&M University and the CSBM was processed at a commercial soybean crush facility.
[3]Samples were analyzed at the University of Missouri Agricultural Experiment Station Chemical Laboratories in Columbia, MO.

Table 2. Diet composition balanced at 20% CP[1,2,3]

Ingredient, %	CSBM	42SBM	49SBM	52SBM
Soybean meal[3]	43.80	47.25	41.03	38.29
Dextrose	50.08	46.63	52.85	55.59
Vegetable oil	2.00	2.00	2.00	2.00
Dicalcium phosphate	1.90	1.90	1.90	1.90
Limestone	1.00	1.00	1.00	1.00
Sodium bicarbonate	0.20	0.20	0.20	0.20
Sodium chloride	0.20	0.20	0.20	0.20
Titanium dioxide	0.50	0.50	0.50	0.50
Vitamin trace mineral premix	0.32	0.32	0.32	0.32
Total	100	100	100	100
Calculated analysis				
ME, kcal/lb	1385	1366	1400	1415
Crude protein, %	20	20	20	20
Amino acids, %				
Lys	1.30	1.40	1.22	1.14
Arg	1.42	1.54	1.33	1.24
His	0.53	0.57	0.49	0.46
Ile	0.98	1.05	0.91	0.85
Leu	1.55	1.68	1.46	1.36
Met	0.28	0.31	0.27	0.25
Total sulfur AA	0.60	0.64	0.56	0.52
Phe	1.03	1.12	0.97	0.90
Total aromatic AA	1.80	1.95	1.69	1.58
Thr	0.78	0.84	.073	0.68
Trp	0.28	0.30	0.26	0.25
Val	1.01	1.09	0.95	0.88

[1] At hatch, 240 male broilers (Cobb 500, Cobb-Vantress, Siloam Springs, AR) were placed in battery cages with 6 broilers per cage and 10 replicates per treatment.

[2] Dietary treatments consisted of 1 of 4 soybean meal sources included in diets formulated to 20% crude protein (CP).

[3] Dietary treatments consisted of one of the following soybean meal (SBM) sources: control (47% CP; CSBM), a low quality SBM (42% CP; 42SBM), a medium quality SBM (49% CP; 49SBM), and a high quality SBM (52% CP; 52SBM) where 42SBM, 49SBM, and 52SBM soybeans were processed into SBM using a pilot scale facility at Texas A&M University and the CSBM was processed at a commercial soybean crush facility.

Table 3. Effect of soybean meal source on apparent ileal digestibility of amino acids[1,2,3]

Item	CSBM	42SBM	49SBM	52SBM	SEM	Probability, *P*<
Total AA, %	87.63[a]	80.33[c]	84.94[b]	87.32[a]	0.583	0.001
Indispensable AA, %						
Arg	93.12[a]	88.20[c]	90.99[b]	92.73[a]	0.374	0.001
His	89.81[a]	82.66[c]	87.53[b]	89.68[a]	0.514	0.001
Ile	87.65[a]	82.50[b]	85.99[a]	88.09[a]	0.556	0.001
Leu	87.73[ab]	83.50[c]	86.44[b]	88.59[a]	0.542	0.001
Lys	89.65[a]	81.54[c]	86.25[b]	88.41[a]	0.535	0.001
Met	90.44[a]	85.61[b]	89.35[a]	90.75[a]	0.528	0.001
Phe	88.95[a]	85.19[b]	87.69[a]	89.61[a]	0.509	0.001
Thr	81.68[a]	72.97[c]	77.97[b]	81.53[a]	0.876	0.001
Trp	89.18[a]	85.41[b]	88.28[a]	89.84[a]	0.507	0.001
Val	86.05[ab]	80.24[c]	83.91[b]	86.45[a]	0.649	0.001

[1]At hatch, 240 male broilers (Cobb 500, Cobb-Vantress, Siloam Springs, AR) were placed in battery cages with 6 broilers per cage and 10 replicates per treatment.

[2]Dietary treatments consisted of 1 of 4 soybean meal sources included in diets formulated to 20% crude protein (CP).

[3]Dietary treatments consisted of one of the following soybean meal (SBM) sources: control (47% CP; CSBM), a low quality SBM (42% CP; 42SBM), a medium quality SBM (49% CP; 49SBM), and a high quality SBM (52% CP; 52SBM) where 42SBM, 49SBM, and 52SBM soybeans were processed into SBM using a pilot scale facility at Texas A&M University and the CSBM was processed at a commercial soybean crush facility.

[4]Means within a row followed by a different letter ([a-c]) are significantly different ($P \leq 0.05$).