

Exp. 818

Research report

**Amino acid digestibility in cheese co-product, in fish meal, and in HP 300 fed to weanling
pigs**

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OBJECTIVE

It was the objective of this experiment to measure the apparent ileal digestibility and the standardized ileal digestibility of amino acids (AA) by weanling pigs in a cheese co-product, in a fish meal, and in a HP 300 when fed to weanling pigs.

MATERIALS AND METHODS

The protocol for the experiment was reviewed and approved by the Institutional Animal Care and Use Committee at the University of Illinois at Urbana-Champaign.

Eight weanling barrows that were the offspring of Line 359 boars mated to Camborough sows (Pig Improvement Company, Hendersonville, TN) with an average initial BW of 11.0 ± 0.4 kg that had a T-cannula installed in the distal ileum (Stein et al., 1998) were allotted to a replicated 4×4 Latin square design with 4 diets and four 7 d periods in each square. There was 2 pigs per diet in each period for a total of 8 observations per treatment. Pigs were placed in individual pens (1.2×1.5 m) that were equipped with a self-feeder, a nipple waterer, and a slatted tri-bar floor.

A HP 300, fish meal, and cheese co-product were the ingredients that were used (Table 1). Three diets were based on HP 300, fish meal, or cheese co-product as the only AA-containing ingredients. An N-free diet was included in the experiment to measure basal endogenous losses of crude protein (CP) and AA (Table 2). Thus, a total of 4 diets were used. Vitamins and minerals were included in all diets to meet or exceed the estimated nutrient requirements for growing pigs (NRC, 2012). All diets also contained 0.40% chromic oxide as an indigestible index. Pigs were limit fed to 3.2 times their estimated energy requirement for maintenance (i.e., $197 \text{ kcal/kg BW}^{0.60}$; NRC, 2012), but throughout the experiment, pigs had free access to water.

The first 5 d of each period was considered the adaptation period to the diet, whereas ileal digesta were collected for 8 h on d 6 and 7 of each period. A 225-mL plastic bag was attached to the cannula barrel using a cable tie and digesta flowing into the bag were collected. Bags were removed every 30 min, or whenever full, and replaced with a new bag. Digesta were stored at -20°C immediately after collection.

At the conclusion of the experiment, ileal digesta were thawed and mixed within animal and diet, and a subsample was collected for analysis. Samples of all diets and of each of the AA-containing ingredients were also collected. Ileal digesta were lyophilized and finely ground before analysis. Samples of diets, digesta, and ingredients were analyzed for CP (method 990.03; AOAC Int., 2007) and dry matter (**DM**; method 930.15; AOAC Int., 2007). These samples were also analyzed for AA (method 982.30 E [a, b, c]; AOAC Int., 2007), and diets and digesta samples were analyzed for chromium (method 990.08; AOAC Int., 2007).

The apparent ileal digestibility (**AID**) and the standardized ileal digestibility (**SID**) of CP and AA were calculated for the three diets containing HP 300, fish meal, or cheese co-product as previously described (Stein et al., 2007). The basal endogenous losses of CP and AA were calculated from pigs fed the N-free diet. Values calculated for these 3 diets also represent the values for each ingredient.

Data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC). The normality of residuals and outliers were tested using the UNIVARIATE procedure of SAS. Data for AID and SID of CP and AA were analyzed using a model that included diet as fixed effect and pig and period as random effects. The pig was the experimental unit for and differences were considered significant at $P < 0.05$.

RESULTS

Pigs readily consumed their assigned diets and remained healthy throughout the experiment. The analyzed CP and AA composition of HP 300 was 56.07 % CP and 3.07% Lys, fish meal was 64.99 % CP and 4.84 % Lys, and the cheese co-product was 43.65 % CP and 2.98 % Lys (Table 1).

No difference was observed between HP 300 and fish meal for AID of CP and most AA, but the cheese co-product was greater ($P < 0.05$) for AID of CP and most AA compared with HP 300 or fish meal (Table 3). Likewise, the SID of CP and most AA was not different between HP 300 and fish meal, but these protein sources had lower SID of CP and most AA ($P < 0.05$) compared with cheese co-product (Table 4). It therefore appears that the processing of co-product resulted from making cheese was effective in maintaining AA digestibility in the ingredient. Thus, the cheese co-product is highly digestible in terms of amino acids when fed by weanling pigs.

REFERENCES

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- Stein, H. H., B. Sève, M. F. Fuller, P. J. Moughan, and C. F. M. de Lange. 2007. Invited review: Amino acid bioavailability and digestibility in pig feed ingredients: Terminology and application. *J. Anim. Sci.* 85:172-180. doi:10.2527/jas.2005-742

Table 1. Composition (as-is basis) of ingredients

Item, %	HP 300	Fish meal	Cheese co-product
DM, %	95.19	92.20	96.91
CP, %	56.07	64.00	43.65
Indispensable AA, %			
Arg	3.83	3.73	2.60
His	1.45	1.38	1.21
Ile	2.71	2.59	2.19
Leu	4.24	4.22	3.63
Lys	3.07	4.84	2.98
Met	0.77	1.68	0.82
Phe	2.90	2.43	2.31
Thr	2.09	2.41	1.62
Trp	0.70	0.64	0.62
Val	2.77	2.92	2.41
Dispensable AA, %			
Ala	2.32	3.89	1.62
Asp	6.04	5.43	4.14
Cys	0.79	0.51	0.45
Glu	9.57	7.86	7.98
Gly	2.28	4.65	1.44
Pro	2.77	2.93	2.96

Ser	2.27	2.00	1.90
Tyr	2.05	1.91	1.93

Table 2. Composition (as-is basis) of experimental diets¹

Ingredient, %	Diet			
	HP 300	Fish meal	Cheese co-product	N-free
HP 300	36.00	-	-	-
Fish meal	-	29.05	-	-
Cheese co-product, 50 % CP		-	40.00	
Milk, lactose	20.00	20.00	20.00	20.00
Cornstarch	38.75	50.00	35.00	67.90
Soybean oil	2.00	0.00	2.00	4.00
Solca flok	-		-	4.00
Dicalcium phosphate	1.30	0.00	1.05	2.15
Limestone	1.00	0.00	1.00	0.50
Chromic oxide	0.40	0.40	0.40	0.40
Magnesium oxide	-	-	-	0.10
Potassium carbonate	-	-	-	0.40
Sodium chloride	0.40	0.40	0.40	0.40
Vitamin-micromineral premix ¹	0.15	0.15	0.15	0.15
Total	100.00	100.00	100.00	100.00
Analyzed composition				
DM, %	93.11	92.27	94.13	92.09
CP, %	19.00	18.79	17.63	0.11

Indispensable AA, %

Arg	1.38	1.16	1.02	0.01
His	0.52	0.45	0.51	0.00
Ile	0.95	0.86	0.88	0.02
Leu	1.54	1.44	1.53	0.02
Lys	1.15	1.66	1.25	0.01
Met	0.28	0.56	0.33	0.00
Phe	1.05	0.80	0.96	0.01
Thr	0.78	0.82	0.70	0.01
Trp	0.26	0.19	0.24	0.02
Val	0.97	0.95	0.98	0.01

Dispensable AA, %

Ala	0.86	1.26	0.68	0.01
Asp	2.22	1.81	1.74	0.01
Cys	0.28	0.16	0.19	0.00
Glu	3.62	2.73	3.54	0.02
Gly	0.85	1.40	0.60	0.01
Pro	1.02	0.90	1.31	0.01
Ser	0.88	0.73	0.85	0.01
Tyr	0.66	0.51	0.71	0.01

¹The vitamin-micromineral premix provided the following quantities of vitamins and micro minerals per kg of complete diet: vitamin A as retinyl acetate, 11,150 IU; vitamin D₃ as cholecalciferol, 2,210 IU; vitamin E as selenium yeast, 66 IU; vitamin K as menadione

nicotinamide bisulfate, 1.42 mg; thiamin as thiamine mononitrate, 1.10 mg; riboflavin, 6.59 mg; pyridoxine as pyridoxine hydrochloride, 1.00 mg; vitamin B₁₂, 0.03 mg; D-pantothenic acid as D-calcium pantothenate, 23.6 mg; niacin, 44.1 mg; folic acid, 1.59 mg; biotin, 0.44 mg; Cu, 20 mg as copper chloride; Fe, 125 mg as iron sulfate; I, 1.26 mg as ethylenediamine dihydriodide; Mn, 60.2 mg as manganese hydroxychloride; Se, 0.30 mg as sodium selenite and selenium yeast; and Zn, 125.1 mg as zinc hydroxychloride.

Table 3. Apparent ileal digestibility (AID) of crude protein and amino acids in HP 300, fish meal, and cheese co-product¹

Item	HP 300	Fish meal	Cheese co-product	Pooled SEM	<i>P</i> -value
CP	72.83 ^b	70.18 ^b	80.89 ^a	2.30	0.009
Indispensable AA					
Arg	88.92	86.98	91.13	1.14	0.067
His	81.64 ^b	79.13 ^b	88.31 ^a	1.64	0.002
Ile	81.49 ^b	81.26 ^b	86.91 ^a	1.77	0.019
Leu	83.09 ^b	83.77 ^b	89.39 ^a	1.57	0.004
Lys	76.61 ^b	82.14 ^{ab}	86.63 ^a	2.24	0.011
Met	83.42 ^b	85.76 ^b	90.45 ^a	1.32	0.002
Phe	83.50 ^b	79.47 ^b	88.29 ^a	1.58	0.001
Thr	69.08 ^b	76.08 ^a	77.18 ^a	2.03	0.017
Trp	79.41 ^b	81.09 ^{ab}	85.93 ^a	1.57	0.029
Val	76.96 ^b	78.63 ^b	85.04 ^a	1.87	0.005
Dispensable AA					
Ala	72.67 ^b	80.29 ^a	78.96 ^{ab}	2.24	0.044
Asp	76.71 ^{ab}	74.59 ^b	81.77 ^a	1.81	0.013
Cys	52.21	52.71	61.93	4.21	0.196
Glu	80.53 ^b	80.79 ^b	87.71 ^a	2.23	0.043
Gly	56.04 ^b	73.32 ^a	65.38 ^{ab}	3.57	0.010
Pro	74.85 ^{ab}	64.30 ^b	79.58 ^a	5.29	0.036

Ser	76.73 ^b	78.41 ^{ab}	83.64 ^a	1.77	0.029
Tyr	81.14 ^b	78.12 ^b	88.97 ^a	1.74	0.001

^{a-b}Least squares within a row lacking a common superscript letter are different ($P < 0.05$).

¹Each least squares mean represents 8 observations per diet, except cheese co-product diet that mean represents 7 observations.

Table 4. Standardized ileal digestibility (SID) of crude protein and amino acids in HP 300, fish meal, and cheese co-product^{1,2}

Item	HP 300	Fish meal	Cheese co-product	Pooled SEM	<i>P</i> -value
CP	82.05 ^b	79.41 ^b	90.93 ^a	2.30	0.005
Indispensable AA					
Arg	92.85 ^{ab}	91.58 ^b	96.46 ^a	1.14	0.024
His	86.51 ^b	84.70 ^b	93.32 ^a	1.64	0.003
Ile	86.36 ^b	86.58 ^b	92.21 ^a	1.77	0.015
Leu	86.67 ^b	87.64 ^b	93.09 ^a	1.57	0.005
Lys	81.17 ^b	85.27 ^{ab}	90.86 ^a	2.24	0.013
Met	87.74 ^b	87.90 ^b	94.16 ^a	1.32	0.001
Phe	87.93 ^b	85.23 ^b	93.19 ^a	1.58	0.001
Thr	79.54 ^b	85.95 ^{ab}	88.97 ^a	2.03	0.014
Trp	85.48 ^b	89.31 ^{ab}	92.57 ^a	1.57	0.021
Val	83.48 ^b	85.23 ^b	91.60 ^a	1.87	0.005
Dispensable AA					
Ala	80.18 ^b	85.37 ^{ab}	88.55 ^a	2.24	0.041
Asp	80.86 ^b	80.35 ^b	87.89 ^a	1.81	0.006
Cys	63.64 ^b	72.54 ^{ab}	78.96 ^a	4.21	0.048
Glu	83.85	85.16	91.13	2.23	0.054
Gly	71.93 ^b	82.89 ^{ab}	88.14 ^a	3.57	0.017
Pro	96.17	88.25	96.36	5.29	0.2607

Ser	84.31 ^b	87.47 ^{ab}	91.57 ^a	1.77	0.026
Tyr	86.78 ^b	85.35 ^b	94.27 ^a	1.74	0.002

^{a-b}Least squares within a row lacking a common superscript letter are different ($P < 0.05$).

¹Each least squares mean represents 8 observations per diet, except cheese co-product diet that mean represents 7 observations.

²Values for SID were calculated by correcting the values for apparent ileal digestibility for basal ileal endogenous losses. Basal ileal endogenous losses were determined (g/kg of dry matter intake) as crude protein, 18.80; Arg, 0.58; His, 0.27; Ile, 0.50; Leu, 0.79; Lys, 0.56; Met, 0.13; Phe, 0.50; Thr, 0.88; Trp, 0.17; Val, 0.68; Ala, 0.69; Asp, 1.13; Cys, 0.34; Glu, 1.29; Gly, 1.45; Pro, 2.34; Ser, 0.72; and Tyr, 0.40.