Director's Digest

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Prediction Equations for Amino Acid (AA) Digestibility in Meat and Bone Meals (MBM).

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Introduction:

More than 500 million tons of animal feeds are produced annually in the world from which 70% are for poultry and swine. It is increasingly important to define the feeding values of ingredients being used in commercial formulation for all animals. Some of the compositional data on feedstuffs is in data banks that are several years old. In the case of animal by-products many of the processes and raw material controls have improved. Feedstuffs have changed thus many of the commercially available composition tables are not used extensively in practical feed formulation.

Ingredient variability can significantly alter its value when used in least cost formulation models. It is a widely held belief that tabular values may not accurately reflect the feeding value of a particular shipment of a feed ingredient.

Feed formulation practices could benefit via an accurate "in vivo" prediction procedure for digestibility values using easily - measured laboratory analyses. The values used would be more reliable than table values as they would be obtained on ingredients actually used in formulation. To date the predictability proposed procedures have been expensive and most attempts to use simple laboratory tests to predict feeding value have been based on a simple variable.

The objective of this project was to develop prediction equations that employ more than one quickly measured variable and relatively inexpensive analytical procedures.

Methodology:

Samples of MBM were obtained from various animal protein procedures and suppliers. Twenty-nine 200 lb. samples of MBM from the commercial trade that had been appropriately characterized according to:

- an estimate (%) of species source of raw materials
- an estimation (%) of raw material tissue components.
- a description that included processing equipment and procedures.
- a description of cooking and drying processing times and temperatures.
- grind and particle size of finished product and a
- basic proximate analysis

were sent to the University of Illinois during early 1996. In vivo assays of each sample was replicated in 3 pigs during a one - week feeding period. The collection was performed using the T - cannula procedure as described by Easter and Tanksley (1993) and Bellaver (1989). Meal digestibilities were determined for crude protein, lysine, tryptophan and methionine plus cystine. Laboratory analysis included: dry mater (DM), crude protein (CP), fat extract, ash, Ca, P, pepsin digestion, pH multi enzyme decay, total amino acids, chromium and near - infrared reflectance spectroscopy (NIR) analysis. Prediction equations were calculated using SAS Statistical Users Guide.

Results:

The compositional data for each of the respective samples are included in Table 1 with average, standard deviations, maximum and minimum values summarized. The average crude protein, lysine, tryptophane and methionine - cystine ileal digestibility values are presented in Table 2. A single soybean meal sample result is included.

The following prediction equations were developed to predict in vivo digestibility.

Equations:

C P Digestibility = 46.97 + 3.17 calcium - 9.09 phosphorus + 0.32 CPHCLP [1] + 0.31 MBMCAS[2]

[1] CPHCLP = Crude protein soluble in HCL + Pepsin

[2] MBMCAS = Meat & Bone Casein ratio Prob > F = 0.002 $R^2 = 0.71$

Lysine digestibility = 44.52 + 15.55 DIFPH[1]

[1] DIFPH = Differential of Ph initial and 10 minutes Prob > F = 0.0004 $R^2 = 0.42$

Methionine + Cystine Digestibility = 66.74 - 1.47 Dry Matter + 2.19 Calcium + .0065 particle size + 14.45[1] PHDEZ

[1]PHDEZ = pH multi enzyme decay. Prob > F = 0.001 $R^2 = 0.74$

Table 3 outlines the predicted availability for crude protein and lysine digestibility as compared to the values obtained via ileal digestibility procedures. It was concluded that in vivo digestibility can be predicted from rapidly measures variables. The actual procedures used in the laboratory analyses must be defined to accompany the evaluations.

The analytical composition data illustrates the inherent variability of ingredients but standard deviations that are improved over several data bases. The average ileal digestibilities for lysine of 70.87% and for tryptophane of 69.70% as determined in this study compares to those contained in

Table 6-6 of the Ninth Revised Edition of the Nutrient Requirements of Swine for lysine at 64% and tryptophane at 53%.

The composition of raw material and processing conditions are summarized in Table 4. Individual suppliers of the respective samples will be provided with sample identification for the products they submitted. As per conditions of this study confidentiality of the sample source will be maintained. The following companies are given our gratitude for complying with the request and supply of appropriately labeled material in a timely manner:

Anamax Co.
Baker Commodities
Birmingham Hide & Tallow, Inc.
C B P Resources
Central Bi-Products
Darling Int. Inc.
Excel Corp.
Farmland Industries
G. A. Wintzer & Sons Co.
Griffin Industries
Hatfield Quality Meats Inc.
Maricopa By Products
Modesto Tallow Co.
MOPAC
National By-Products
Rothsay
Sanimal Industries Inc.
The Standard Fertilizer Co.
Taylor By-Products
Valley Protein
Van Hoven Co. Inc.
West Coast Reduction, Ltd.

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Table 1

Compositional data for MBM received through Fats and Protein Association [1]

Sample	DM	CPAIS	CPDM	Fat	Ash	Ca	P	THR	CYS	MET	LYS	TRY
MBM1	96.86	57.20	59.05	13.56	26.85	6.70	3.09	2.02	0.53	0.93	3.24	0.40
MBM2	97.38	47.50	48.78	24.10	35.99	10.24	4.36	1.28	0.41	0.53	1.93	0.19
MBM3	95.91	59.08	61.60	24.37	20.93	6.09	2.70	1.99	0.60	0.85	3.09	0.37
MBM4	95.64	55.21	57.73	15.95	29.59	8.57	3.80	1.83	0.55	0.89	2.90	0.27
MBM5	98.02	55.06	56.16	17.06	26.15	6.93	3.57	2.10	0.59	1.04	3.04	0.35
MBM6	97.52	55.76	57.17	16.62	26.93	7.19	2.56	2.06	0.67	0.91	3.16	0.36
MBM7	95.17	46.29	48.64	17.27	32.13	8.72	4.11	1.49	0.48	0.61	2.31	0.17
MBM8	96.01	55.26	57.56	15.41	30.15	8.90	4.06	1.92	0.54	0.93	3.01	0.37
MBM9	94.40	47.13	49.92	16.05	30.07	7.51	4.86	1.69	0.45	0.81	2.65	0.32
MBM10	97.72	53.02	54.25	13.51	29.97	8.90	4.25	1.76	0.53	0.75	2.64	0.26
MBM11	98.40	57.05	57.97	16.48	25.01	6.53	3.31	2.12	0.45	0.98	3.21	0.31
MBM12	94.75	57.17	60.37	16.33	23.18	6.78	3.35	1.95	0.59	0.88	3.23	0.33
MBM13	94.73	57.04	60.21	15.35	25.09	8.01	3.96	1.84	0.51	0.79	3.00	0.33
MBM14	96.28	48.02	49.87	15.45	28.47	7.91	3.51	1.54	0.53	0.55	2.35	0.26
MBM15	93.19	55.04	59.06	19.87	23.44	7.16	3.52	1.82	0.79	0.75	2.65	0.25
MBM16	96.29	45.88	47.65	19.63	23.39	6.50	3.25	1.66	0.53	0.61	2.49	0.25
MBM17	95.19	53.39	56.08	15.84	27.26	7.54	3.57	2.01	0.56	0.88	3.34	0.40
MBM18	94.43	48.90	51.79	18.47	27.95	7.12	3.68	1.95	0.41	0.78	2.80	0.36
MBM19	97.32	47.15	48.44	10.99	37.57	11.80	5.57	1.38	0.41	0.57	2.18	0.23
MBM20					No Sample Submitted							
MBM21	93.03	47.90	51.48	17.90	30.03	8.42	4.17	1.51	0.41	0.64	2.37	0.27
MBM22	96.59	56.00	57.97	14.68	22.87	6.52	3.34	2.10	0.65	0.88	3.19	0.36
MBM23	95.53	52.24	54.68	13.21	29.08	8.19	4.00	1.63	0.51	0.68	2.65	0.28
MBM24	95.83	56.14	58.58	15.61	21.75	6.02	3.08	1.99	0.50	0.88	3.22	0.42
MBM25	95.35	51.32	53.82	25.03	28.83	8.94	4.09	1.77	0.42	0.81	2.85	0.32
MBM26	97.05	55.89	57.59	12.62	27.88	8.18	3.77	1.96	0.51	0.89	3.21	0.33
MBM27	94.91	47.48	50.03	18.24	28.54	9.74	4.72	1.41	0.34	0.60	2.35	0.27
MBM28	96.53	55.43	57.42	18.56	19.32	5.26	3.06	1.91	0.56	0.80	3.19	0.34
MBM29	97.62	49.58	50.79	16.99	31.62	10.01	4.98	1.53	0.42	0.64	2.49	0.28
MBM30	96.04	58.52	60.93	15.97	20.65	6.36	3.37	2.06	0.84	0.84	2.90	0.32
AVG	95.90	53.60	55.92	17.00	26.44	7.58	3.67	1.83	0.58	0.78	2.87	0.32
STDS	1.44	5.99	6.52	3.26	6.20	1.96	0.89	.032	.033	0.14	1.49	0.08
MAX	98.40	59.08	61.60	25.03	37.57	11.80	5.57	2.10	0.84	1.04	3.34	0.40
MIN	93.03	45.88	47.65	10.99	19.32	5.26	2.56	1.28	0.34	0.53	1.93	0.17

[1] DM-DRY MATTER: CPAIS=CRUDE PROTEIN IN AS BASIS:: CPDM-CRUDE PROTEIN IN DM BASIS.

Table 2

Average Digestibility

	Crude	Protein	Lysine	Tryptophane	Methonine & Cystine
MBM	1	69.13	68.60	67.34	61.55
MBM	2	66.43	71.72	73.46	64.74
MBM	3	66.03	65.57	67.33	61.45
MBM	4	73.84	76.07	72.40	68.41
MBM	5	60.63	57.05	61.65	51.99
MBM	6	76.24	77.75	73.95	69.51
MBM	7	73.00	78.20	76.74	69.27
MBM	8	74.00	75.24	72.68	71.29
MBM	9	75.59	79.35	68.75	73.25
MBM	10	67.52	67.64	74.23	61.56
MBM	11	55.68	50.10	53.62	57.36
MBM	12	75.19	77.74	74.11	71.32
MBM	13	72.59	77.24	78.20	68.56
MBM	14	78.95	82.48	76.23	70.45
MBM	15	74.28	80.46	78.27	65.54
MBM	16	60.48	63.83	53.06	52.52
MBM	17	76.92	78.30	72.32	70.43
MBM	18	69.66	68.38	69.74	67.94
MBM	19	69.83	76.31	76.67	68.05
MBM	20		No Sample Submitted		
MBM	21	65.45	67.47	63.98	65.74
MBM	22	59.46	61.42	63.04	49.42
MBM	23	65.91	71.26	71.91	61.78
MBM	24	65.67	63.38	57.19	57.11
MBM	25	65.56	66.34	66.92	66.18
MBM	26	68.05	69.57	72.04	65.07
MBM	27	70.13	76.59	79.73	77.72
MBM	28	62.95	63.42	65.18	63.68
MBM	29	63.74	70.14	76.59	65.29
MBM	30	68.80	73.58	67.11	49.56
AVG		68.68	70.87	69.70	64.37
SBM		80.02	83.14	79.06	77.26

Table 3

Sample	Crude Protein Digestibility			Lysine Digestibility		
	In Vivo	Predicted	Residual	In Vivo	Predicted	Residual
MBM 1	69.14	67.17	1.97	68.60	65.39	3.21
MBM2	66.43	66.32	0.11	71.72	71.36	0.36
MBM3	66.03	67.18	-1.15	65.57	66.37	-0.79
MBM4	73.84	74.35	-0.51	76.07	76.82	-0.75
MBM5	60.63	60.01	0.62	57.05	57.23	-0.18
MBM6	76.24	75.49	0.74	77.74	77.17	0.57
MBM7	72.99	75.32	-2.33	78.20	79.77	-1.57
MBM8	74.00	72.88	1.12	75.24	76.34	-1.10
MBM9	75.59	76.06	-0.46	79.35	80.23	-0.88
MBM10	67.53	67.53	0.44	67.64	68.45	-0.81
MBM11	55.68	56.49	-0.81	50.10	53.11	-3.01
MBM12	75.19	73.37	1.82	77.74	73.65	4.09
MBM13	72.59	73.30	-0.71	77.24	78.68	-1.44
MBM14	78.95	77.31	1.64	82.48	82.26	0.22
MBM15	74.28	73.77	0.51	80.46	79.45	1.01
MBM16	60.48	60.46	0.02	63.83	62.23	1.60
MBM17	76.92	77.37	-0.45	78.30	78.39	-0.09
MBM18	69.66	70.77	-1.11	68.37	73.31	-4.94
MBM19	69.83	69.57	0.26	76.31	76.13	0.17
MBM20			No Sample Submitted			
MBM21	65.44	64.39	1.05	67.47	65.73	1.74
MBM22	59.46	60.89	-1.43	61.42	60.87	0.55
MBM23	65.91	67.50	-1.59	71.26	69.84	1.42
MBM24	65.67	67.72	-2.06	63.39	67.30	-3.91
MBM25	65.56	64.94	0.62	66.34	66.53	-0.19
MBM26	68.05	68.09	-0.04	69.57	70.37	-0.80
MBM27	70.13	70.22	-0.09	76.59	72.18	4.41
MBM28	62.95	61.14	1.81	63.12	62.80	0.62
MBM29	63.74	63.65	0.09	70.14	69.65	0.49
MBM30	68.80	68.90	-0.10	73.58	73.57	0.01
AVG	68.68	68.68	-0.00069	70.87	70.87	0.000345

Table 4: Composition and Processing Descriptions

Sample	Species	Components	Cooking Time	Cooking Temp.	Drying Time	Drying Temp	Grind
MBM-1	90% beef, 10% pork	-	-	-	2 1/2	225°F	10 Mesh
MBM-2	100% beef	75% offal, 25% bone		290°-300°F	20 ton/hr. feed		#8
MBM-3	100% pork	offal & bone	45 min	130° C	No Heat	1-2 mm	
MBM-4	12% pork, 38% beef, 50% poul.	85% soft, 15% bone	4hrs.	260°F	-	-	10Mesh
MBM-5	65% beef, 20% poul. 10% swine, 5% fish	90% soft, 10% bone	1hr.	280/300°F	-	-	10 Mesh
MBM-6	1/3 beef, 1/3 pork, 1/3 poul.	-	45 min.	260° F	-	-	8 Mesh
MBM-7	60% beef, 40% pork	100% offal	20 min.	257°F	-	-	8 Mesh
MBM-8	45% beef, 55% poul.	55% Viscera, 45% bone	13 1/2min	155°F 2311	-	-	8 Mesh
MBM-9	100% beef	82% soft, 18% bone	Low temp.		45 min.	240°F	10 Mesh
MBM-10	100% beef	82% soft 18% bone	low temp		45 min.	240°F	10 Mesh
MBM-11	28% beef, 33% pork, 38% poul., 1% fish	42% viscera, 23% fat 22% bone, 10% muscle, 3% skin	-	260/290°F	-	-	-
MBM-12		No Information Obtained					
MBM-13	100% pork	No Processing Information Obtained					
MBM-14	90% beef, 10% pork	49% offal, 22% fat 25% bone, 4% skin & trim	20 min.	250°F	-	-	10 Mesh
MBM-15	14% beef, 77% pork, 9% poul.	70% offal, 15% bone 15% fat	1 1/2 hrs.	240°F	-	-	-
MBM-16	70% beef, 30% pork	50% offal, 20% bone 25% shop fat, 5% Rest. Grease bottoms	1hr.	280°F	-	-	10 Mesh
MBM-17	75% beef, 23% pork, 2% poul.	50% offal, 15% fat, 15% bone, 20% meat	30 + min	270°F	290°F at press		1.7 mm
MBM-18	100% beef	40% offal, 45% fat, 15% bone	30 + min	270°F	290°F at press		1.7 mm
MBM-19	100% beef	80% bone, fat & offal 20% tissue	30 min	280°F	-	-	10 Mesh
MBM-20		No Sample Submitted					
MBM-21	60% beef, 40% pork	40% offal, 60% fat trim & bone	65 min	280°F	-	-	10 Mesh
MBM-22	30% beef, 30% pork, 40% locker plant	-	3 1/2 hr	260°F	-	-	5/16
MBM-23	40% beef, 60% pork	67% meat, 30% bone		90 min	270°F		12 Mesh
MBM-24	98% beef, 2% poul.	80% bone, fat & offal		30 min	280°F		10 Mesh
MBM-25	15% beef, 20% pork, 65% poul.	65% offal, 27.5% bone, 7.5% fat		No Time	260 - 280° F		10 Mesh
MBM-26	75% beef, 25% pork & poul.	65% offal, 30% bone, 5% fat	No Time	260-280°F		10 Mesh	
MBM-27	100% pork	-	2 1/2 hrs.	230°F	-	-	-
MBM-28	30% beef, 70% pork	-	30 min	195°F	30 min.	212°F	10 Mesh
MBM-29	98% beef, 2% pork	75% offal, 25% bone	_	290°-300°F	-	-	10 mesh
MBM30	10% beef, 90% pork	-	20min	262°F	-	-	10 mesh