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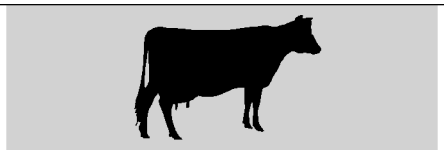

CASE STUDY: Variability in Chemical Composition and Digestibility of Twelve By-Product Feedstuffs Utilized in the California Dairy Industry[1]

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ABSTRACT

The objective of this descriptive study was to measure the amount of variability in the composition of 12 by-product feedstuffs commonly used in rations for lactating dairy cows in California. This study followed a prior descriptive study that was designed to provide the beginning of a nutrient database of by-product feedstuffs. Eleven of the by-product feedstuffs were from a single manufacturer source, with only soybean samples obtained from multiple sources. Samples of each by-product feedstuff were obtained from various locations in California and several locations outside the state. Variability in chemical composition and digestibility are discussed within each of the by-product feedstuff subgroups. Variation generally tended to be within acceptable ranges, although a wider variability was observed when sample numbers were smaller or the absolute value of the nutrient being measured was low.

Key words: by-product feedstuff, composition, variability, dairy cattle, digestibility

INTRODUCTION

By-product feedstuffs (**BPF**) play an important role in the rations of lactating dairy cattle in California (Grasser, 1995) and other parts of the United States (Belyea et al., 1989). In a previous study, a BPF was defined as a product which has value as an animal feed and is obtained during the harvesting or processing of a commodity from which human food or fiber is derived (Fadel, 1999). A BPF may be a product coming from the processing of a raw commodity, such as citrus pulp from orange juice production or hulls from almond processing (DePeters et al., 2000). A BPF may also be the result of rejected products from human food supplies because of spoilage or failure to meet product specifications. Examples include bakery waste and rejected fruits and vegetables. A number of BPF commonly used in the California dairy industry were evaluated in a previous study (DePeters et al., 2000). In the current study, an additional group of BPF was assessed. Some of these BPF are fortified or further processed to enhance the quality and desirability of these products for animal feed.

In the previous study, DePeters et al. (2000) addressed some of the important aspects of the BPF segment of the feed industry. These included the difficulty in quantifying the amounts of BPF produced and their values, the issues in disposing of BPF other than as a livestock feedstuff, the lack of research on nutritive values of individual BPF, and the variable chemical composition of BPF. Since then, none of these issues have been resolved to any extent. In fact, some may become more difficult to deal with in the future. Expanding markets for ethanol and food products for human

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consumption may significantly increase the quantities of BPF available. It may be difficult to determine how much BPF is available in a rapidly expanding marketplace. Disposal of BPF through channels other than the livestock industry may be limited due to landfill regulations and space limitations. Variability in the quantity and quality of BPF appears to be the main challenge in utilizing these products in rations for dairy cattle. The BPF quality may vary for several reasons. Processing techniques between plants may result in different nutrient levels for the same BPF (i.e. distillers grains or soybean products). Seasonal quality variation of a raw ingredient may result in differences in the BPF. For example, as soybean quality changes from year to year, CP levels in soybean meal may change also. As processing technologies improve to capture more value from products, the historical nutritive values of BPF may change over time. For example, increased efficiency in the sugar extraction process has resulted in a reduction in the energy level of beet pulp. St. Pierre (2001) discussed the risks of variability in rations for dairy cattle but stated that by measuring the variability, the risk can be minimized and managed. The objective of the current study was to measure variability in products commonly used in rations for dairy cattle in California that were not addressed in the previous study.

MATERIALS AND METHODS

Sampling

The BPF selected for evaluation included Amino Plus (Ag Processing, Inc., Omaha, NE), AP301 (American Protein Corporation, Ames, IA), dried bakery product (Recycle to Conserve, Inc., Santa Monica, CA), Dakota Gold distillersdistillers grains (Dakota Gold Marketing, Scotland, SD), dried distillersdistillers grains (Commodity Specialists Co., Minneapolis, MN), dried distillersdistillers grains (ADM Processing Co., Decatur, IL), Pro-Lak (H.J. Baker & Bro., Inc., Westport, CT), Sea-Lac (Omega Protein, Inc., Hammond, LA), 47% soybean meal, Soy Best (Grain States Soya, Inc., West Point, NE), SoyPass (Borregaard LignoTech, Rothschild, WI), and SoyPlus (West Central Cooperative, Ralston, IA). Inspectors and special investigators from the California Department of Food and Agriculture (**CDFA**) Division of Inspection Services and select members from the California ARPAS By-Product Committee obtained samples of each BPF according to state sampling protocol. One exception was with the Soy Best product, which was not available in California during part of the sampling period. One sample was taken by CDFA, 8 samples were obtained by the Nebraska Department of Agriculture, and one sample was taken by the Idaho Grain Inspection Service, Inc. These were then forwarded to the CDFA. Single sources for each BPF, with the exception of soybean meal, were identified, and 10 samples of each BPF were obtained between August 2002 and September 2004. A single source is defined as all samples of the BPF being obtained from one originating source, but not necessarily the same destination source. After field collection, samples were sent to the CDFA laboratory. The samples were dried at 50°C, and all samples were ground through a Jacobson mill (Model P88B, Jacobson Machine Works, Inc., Minneapolis, MN).

Chemical Analyses

The CDFA laboratory retained a portion of the ground sample and analyzed that portion for CP, crude fat, crude fiber, ash, and moisture. The remainder of the sample was sent to the Dairy One Forage Laboratory (Ithaca, NY) for chemical analysis. Samples were analyzed for moisture (AOAC, 1995), CP (AOAC, 1995), soluble protein (Roe and Sniffen, 1990), and degradable protein (Roe and Sniffen, 1990). Lignin was determined according to AOAC (1995) method 973.18D, modified with no asbestos. Acid detergent fiber was determined using the ANKOM A200 filter bag technique and solutions prepared according to AOAC (1990) method 973.18C. Neutral detergent fiber was determined using the ANKOM A200 filter bag technique and solution prepared according to Van Soest et al. (1991). Retained residues for the ADF and NDF methods were analyzed for N content using the Kjeldahl method to provide acid-detergent insoluble protein (**ADICP**) and NDF-CP, respectively. Crude fat analysis was by ether extraction (Tecator Soxtec System HT6, Foss, Eden Prairie, MN), and total ash content was measured according to AOAC (1995) method 942.05. Chloride ion was measured using potentiometric titration with $AgNO_3$ via a titration unit (Brinkmann Metrohm 716 Titrino, Brinkmann Instruments, Inc., Westburg, NY) with a silver electrode. Minerals, including Ca, P, Mg, K, Na, Fe, Zn, Cu, Mn, and Mo, were determined as follows: samples were ashed in a muffle furnace at 500°C for 4 h. Three milliliters of 6 *N* HCl was added to the ash residue and evaporated to dryness on a hot plate at 100 to 120°C. Minerals were extracted using an acid solution (1.5 *N* HNO_3 + 0.5 *N* HCl), and the extract was analyzed using inductively coupled plasma spectroscopy (ICAP 61, IRIS Advantage, Thermo Electron Corporation, Franklin, MA). Sulfur was determined by combustion (model SC-432, LECO Corp., St. Joseph, MI). Prediction of the energy content of each BPF was according to Weiss (1995). Starch was analyzed using a biochemistry analyzer (Select Biochemistry Analyzer, YSI, Inc., Yellow Springs, OH; application note number 319). Sugars were analyzed according to the West Virginia University procedure (Hall et al., 1999.)

Amino Acid Determination

A subset of 3 samples for each BPF was chosen for further analysis. These samples included those that fell in the high, low, and median CP value ranges in the 10 sample groups for each BPF. The 3-sample subset for

each BPF was sent to Degussa Corp. (Kennesaw, GA) for total amino acid (**AA**) analysis (Llames and Fontaine, 1994). Residue remaining after determining the buffer soluble CP from the subset of 3 samples was sent from the Dairy One Forage Laboratory to Novus International (St. Louis, MO) for AA analysis of the insoluble protein fraction according to AOAC (1995) method 982.30.

In Situ and Intestinal Digestibility

Samples from the subset of 3 for each original BPF were sent to F.A.R.M.E. Institute (Homer, NY) for in situ analysis. Samples were tested for in situ digestibility using a single high-producing, ruminally-cannulated, lactating dairy cow. The cow used was 80 to 90 DIM and was fed a standard dairy cattle ration balanced according to NRC (2001) recommendations. All samples in each BPF subgroup were run concurrently in the cannulated cow. Individual samples were run in triplicate with approximately 5 g of DM in each subsample. The in situ testing protocol involved weighing samples, in the form they were received, into a 10 × 20 cm nitrogen-free polyester bag with a pore size of 50 μm (± 15). The bags were heat-sealed after filling, and samples were soaked in distilled water prior to incubation in the rumen of the cannulated cow. After incubation for the specified time periods (4, 8, 16, 30, and 48 h), samples were frozen for a minimum of 12 h. They were then thawed and machine-rinsed with cold water. Samples were then fully dried in a convection drying oven (minimum of 12 h at 48.9°C) and weighed. Standard disappearance calculations were used and CV determined for each sample. Outliers were not used in the final average if CV were greater than 10%. Chemical analysis of fat and protein was conducted on both original materials and the digestive residues at Dairy One Forage Laboratory. Disappearance of CP was calculated by determining the grams of CP remaining after digestion and subtracting that quantity from the grams of CP placed into the in situ bag. Disappearance of other nutrients is determined in a similar manner.

Intestinal digestibility was estimated using an in vitro procedure to measure protein disappearance. For each sample in the subset of in situ analysis, 6 g of remaining material from the 16-h incubation period were sent to the University of Minnesota for analysis (Calsamiglia and Stern, 1995). The samples were incubated in a HCl solution containing pepsin for 1 h. After incubation, the solution was neutralized and a buffered solution containing pancreatin was added and incubated for 24 h at 38°C. The remaining undigested proteins were then precipitated using trichloroacetic acid, and the residual insoluble N was measured. Digestibility values were determined by subtracting the remaining ADICP precipitated after the in vitro procedure from the CP in the sample remaining at the end of the 16-h ruminal exposure.

A profile of the chemical composition of the repeated sampling for each BPF was determined by calculating the mean, SD, range, and CV for the samples of each BPF. The probability of selecting a sample of a commodity with a given CP or NDF percentage was determined by calculating the normal probability density function using the mean and SD from the data collected and using a range of reasonable CP or NDF percentages to calculate a complete distribution (Mood et al., 1974).

RESULTS AND DISCUSSION

The BPF are discussed separately because the objective was to evaluate the variability of the chemical composition within a given BPF. Comparisons are made to the tabular values in NRC (2001) where possible. Sources of BPF in the tabular values of NRC (2001) are unknown. Additional comparisons are made between analyses conducted at Dairy One Forage Laboratory and CDFA (Table 1). Variability between laboratories was greater than expected. Without exception, CP values were noticeably lower from Dairy One Forage Laboratory than CDFA. For many of the samples, the difference between the 2 laboratories for average CP concentration was 3 to 5%. There were also differences between the 2 laboratories for crude fat concentration, although differences were not as pronounced as those observed for CP. Fat content was lower when analyzed by Dairy One Forage Lab for most of the samples. Values for ash concentration between labs agreed more closely. Again for the majority of samples, Dairy One Forage Lab values for ash content were higher. The objective of this study was not to compare the differences between laboratories or analytical methods. Some variation in laboratory results is expected. This could be due to a number of factors which include, but are not limited to, sample preparation, sample grind, and analytical method used.

Coefficients of Variation

Coefficients of variation are variable among different BPF and among nutrient parameters. This discussion will address those CV which are high (>10%) and with absolute values that are meaningful. High CV will not be addressed for those nutrients that have low absolute values, as analytical detection limits may contribute to higher estimated variation. Nutrient values may also be subject to variation because of a small number of samples analyzed.

In the nutrient composition table (Table 2), higher CV were observed in ADICP, soluble protein, lignin, and starch for all BPF. Generally, the laboratory values of these nutrients were low (less than 10%). Small standard deviations at these lower absolute values tend to yield a higher CV and may not be useful for this discussion.

This same discussion will hold true for the mineral composition tables (Table 3). Because many of the mineral values are low to begin with, slight variations in analytical results may give a larger CV.

Table 1. Comparison of chemical composition between Dairy One Laboratory, California Department of Food and Agriculture (CDFA), and NRC (where applicable) for feedstuffs (DM basis)

Item	No.	Parameter	Moisture	CP	Crude fat	Crude fiber	ADF	NDF	Ash
			%						
Dakota Gold									
Dairy One	10	Avg[1]	12.00	31.56	13.98	—	15.51	32.41	5.77
		SD	0.86	1.89	1.33	—	1.97	2.69	0.98
		Max	13.70	35.30	15.90	—	18.30	36.10	8.25
		Min	10.40	28.10	11.70	—	13.10	28.40	4.90
CDFA	10	Avg	11.84	32.82	14.50	6.61	—	—	4.71
		SD	2.16	1.37	2.35	1.01	—	—	0.24
		Max	14.30	34.82	18.64	8.30	—	—	5.00
		Min	6.70	30.89	11.85	4.93	—	—	4.18
DDG-ADM[2]									
Dairy One	10	Avg	13.20	31.03	11.91	—	17.98	35.84	7.74
		SD	0.95	0.85	1.98	—	1.85	2.54	1.02
		Max	14.90	31.90	16.60	—	20.70	40.20	9.61
		Min	12.80	29.70	9.30	—	15.10	31.90	6.84
CDFA	10	Avg	10.94	29.89	9.73	7.59	—	—	7.11
		SD	0.84	1.10	1.26	0.56	—	—	0.59
		Max	11.90	31.52	11.46	8.62	—	—	7.73
		Min	9.30	28.14	7.17	6.84	—	—	6.15
DDG[3]									
Dairy One	10	Avg	12.40	32.28	15.89	—	17.15	33.43	7.18
		SD	1.02	0.72	1.61	—	1.85	2.27	0.75
		Max	13.90	33.40	18.40	—	21.30	38.50	8.20
		Min	10.70	30.80	13.50	—	14.40	31.30	5.39
CDFA	10	Avg	10.37	31.80	12.88	7.59	—	—	4.49
		SD	1.87	0.84	1.03	0.65	—	—	0.25
		Max	12.20	32.88	14.50	8.36	—	—	4.77
		Min	6.90	30.01	10.93	6.66	—	—	4.01
NRC		Avg	90.20	29.70	10.00	—	19.70	38.80	5.20
		SD	1.80	3.30	3.40	—	4.60	7.80	1.10
Soybean meal									
Dairy One	10	Avg	11.00	53.13	1.05	—	7.56	10.46	7.35
		SD	0.30	1.33	0.17	—	1.03	0.93	0.26
		Max	11.70	54.50	1.40	—	9.20	11.60	7.78
		Min	10.20	49.40	0.80	—	5.90	8.50	6.99
CDFA	10	Avg	11.57	53.92	1.48	4.14	—	—	8.07
		SD	0.37	0.54	0.32	0.41	—	—	0.10
		Max	12.40	54.93	2.03	4.76	—	—	8.22
		Min	11.20	53.38	1.03	3.51	—	—	7.94
NRC		Avg	10.50	53.80	1.10	—	6.20	9.80	6.40
		SD	1.90	2.10	0.40	—	3.00	5.60	0.70
Soy Best									
Dairy One	10	Avg	11.50	46.59	7.35	—	10.89	21.22	7.08
		SD	0.20	1.56	0.40	—	1.58	1.76	0.37
		Max	11.80	48.20	8.10	—	13.30	25.10	7.60
		Min	11.00	43.00	6.70	—	8.30	18.60	6.41
CDFA	10	Avg	11.69	47.08	7.71	6.32	—	—	7.11
		SD	0.38	0.93	0.54	0.26	—	—	0.28
		Max	12.10	48.24	8.66	6.79	—	—	7.84
		Min	11.10	45.81	7.04	5.98	—	—	6.75
SoyPass									
Dairy One	10	Avg	10.50	51.95	1.84	—	7.67	21.07	6.53
		SD	0.50	1.12	0.45	—	1.49	2.72	0.09
		Max	11.70	54.60	2.90	—	10.50	25.00	6.65
		Min	9.90	50.40	1.50	—	5.70	16.80	6.30
CDFA	10	Avg	11.68	52.45	1.66	3.91	—	—	7.08
		SD	0.62	0.72	0.68	0.25	—	—	0.55
		Max	12.50	53.37	2.94	4.39	—	—	7.38
		Min	10.60	51.41	1.13	3.66	—	—	5.66

Continued

Table 1 (continued). Comparison of chemical composition between Dairy One Laboratory, California Department of Food and Agriculture (CDFA), and NRC (where applicable) for feedstuffs (DM basis)

Item	No.	Parameter	Moisture	CP	Crude fat	Crude fiber	ADF	NDF	Ash
			%						
SoyPlus									
Dairy One	10	Avg	10.10	47.96	6.14	—	10.58	20.17	6.69
		SD	1.30	0.86	0.20	—	1.67	1.50	0.47
		Max	10.80	49.70	6.50	—	13.00	23.00	7.53
		Min	7.20	46.70	5.90	—	8.00	18.30	6.14
CDFA	10	Avg	10.62	48.39	6.05	6.22	—	—	6.99
		SD	1.29	1.17	0.15	0.34	—	—	0.43
		Max	12.20	50.11	6.25	6.69	—	—	8.08
		Min	8.40	47.15	5.81	5.73	—	—	6.49
Amino Plus									
Dairy One	10	Avg	12.60	49.96	1.14	—	8.92	16.08	7.55
		SD	0.40	1.43	0.40	—	1.11	1.47	1.65
		Max	13.30	52.60	2.10	—	10.70	19.50	12.35
		Min	11.70	48.00	0.70	—	6.90	14.30	6.71
CDFA	10	Avg	12.44	50.54	0.90	6.02	—	—	7.87
		SD	0.70	1.11	0.16	0.56	—	—	0.04
		Max	13.50	51.72	1.15	6.97	—	—	7.89
		Min	11.30	48.34	0.68	5.07	—	—	7.84
Pro-Lak									
Dairy One	10	Avg	7.90	79.88	10.10	—	—	—	12.32
		SD	0.80	1.99	1.30	—	—	—	0.51
		Max	8.90	83.00	13.60	—	—	—	13.58
		Min	6.60	76.50	8.80	—	—	—	11.85
CDFA	10	Avg	6.96	80.15	8.58	0.48	—	—	12.34
		SD	0.78	1.48	1.07	0.10	—	—	0.57
		Max	7.80	82.20	10.57	0.65	—	—	13.64
		Min	5.40	78.55	7.59	0.32	—	—	11.76
Sea-Lac									
Dairy One	10	Avg	8.50	70.32	10.31	—	—	—	22.09
		SD	1.30	1.40	1.31	—	—	—	1.33
		Max	10.90	72.50	11.80	—	—	—	23.94
		Min	6.10	68.30	7.20	—	—	—	19.15
CDFA	10	Avg	7.20	69.33	10.63	0.47	—	—	22.27
		SD	2.66	2.55	1.35	0.32	—	—	1.37
		Max	9.80	73.00	12.40	0.89	—	—	24.34
		Min	0.46	63.59	8.31	0.10	—	—	19.44
AP301									
Dairy One	10	Avg	7.50	103.04	—	—	—	—	2.78
		SD	0.50	0.85	—	—	—	—	0.96
		Max	8.10	104.40	—	—	—	—	3.98
		Min	6.40	101.40	—	—	—	—	2.63
CDFA	10	Avg	6.79	100.28	1.36	0.16	—	—	3.10
		SD	0.49	0.61	0.19	0.08	—	—	0.62
		Max	7.50	101.08	1.82	0.21	—	—	4.22
		Min	5.70	99.36	1.08	0.11	—	—	2.36
Bakery									
Dairy One	10	Avg	12.30	13.24	7.76	—	3.80	6.05	3.20
		SD	1.30	0.96	1.33	—	1.21	1.29	0.37
		Max	13.70	14.80	9.50	—	6.60	8.90	4.26
		Min	10.10	12.20	5.90	—	1.90	4.70	2.90
CDFA	10	Avg	12.34	14.23	9.75	1.36	—	—	3.22
		SD	1.82	0.87	1.01	1.41	—	—	0.39
		Max	14.40	15.42	10.93	5.33	—	—	4.21
		Min	8.00	12.93	8.35	0.57	—	—	2.97
NRC		Avg	15.30	12.50	9.50	—	6.50	13.90	3.80
		SD	10.70	3.60	6.20	—	6.50	10.70	1.60

[1]Avg = average (mean), Max = maximum, and Min = minimum.

[2]DDG = dried distillers grains supplied by ADM Processing Co., Decatur, IL.

[3]DDG = dried distillers grains supplied by Commodity Specialists Co., Minneapolis, MN.

Table 2. Nutrient composition of feedstuffs (DM basis)

Description	DM	CP	Available CP	Unavailable CP	Soluble protein	ADF	NDF	Crude fat	TDN	NE_l	NE_n	NE_g	Lignin	Sugar	Starch
	%									Mcal/lb			%		
Dakota Gold															
Avg[1]	87.95	31.56	27.89	3.67	3.70	15.51	32.41	13.98	86.30	0.98	1.04	0.73	4.41	4.86	4.33
SD	0.86	1.89	2.26	0.70	1.27	1.97	2.69	1.33	3.03	0.04	0.05	0.04	1.01	1.35	1.30
Max[1]	89.60	35.30	31.50	5.10	5.00	18.30	36.10	15.90	90.00	1.03	1.03	0.78	6.40	8.10	6.20
Min[1]	86.30	28.10	23.70	2.50	1.00	13.10	28.40	11.70	82.00	0.92	0.98	0.67	3.30	3.70	2.70
CV	0.98	5.99	8.11	19.04	34.29	12.69	8.32	9.50	3.52	4.19	4.75	5.83	22.89	27.75	29.92
DDG-ADM[2]															
Avg	86.76	31.03	24.83	6.23	4.60	17.98	35.84	11.91	79.20	0.89	0.93	0.63	5.78	4.82	5.20
SD	0.95	0.85	0.83	0.93	0.80	1.85	2.54	1.98	4.07	0.05	0.07	0.05	1.58	1.02	1.20
Max	87.20	31.90	26.60	7.60	6.00	20.70	40.20	16.60	90.00	1.04	1.11	0.78	7.80	5.90	7.10
Min	85.10	29.70	23.30	4.70	3.00	15.10	31.90	9.30	75.00	0.85	0.87	0.58	3.10	3.10	3.10
CV	1.10	2.72	3.33	14.96	17.39	10.30	7.10	16.63	5.14	5.99	7.13	8.71	27.38	21.25	23.06
DDG[3]															
Avg	87.58	32.28	26.07	6.23	3.70	17.15	33.43	15.89	86.80	0.99	1.06	0.74	4.94	4.07	3.21
SD	1.02	0.72	1.23	0.87	0.90	1.85	2.27	1.61	3.19	0.04	0.05	0.04	1.39	2.27	0.74
Max	89.30	33.40	27.70	7.50	5.00	21.30	38.50	18.40	91.00	1.05	1.13	0.80	8.50	8.20	4.20
Min	86.10	30.80	23.30	4.80	2.00	14.40	31.30	13.50	81.00	0.92	0.97	0.67	3.40	0.80	2.10
CV	1.17	2.23	4.71	13.94	24.32	10.80	6.80	10.13	3.67	4.44	5.04	5.69	28.21	55.78	23.00
Soybean meal															
Avg	89.02	53.13	51.82	1.33	14.20	7.56	10.46	1.05	79.80	0.83	0.87	0.58	0.92	16.18	2.01
SD	0.35	1.33	1.54	0.66	1.99	1.03	0.93	0.17	0.40	0.01	0.01	0.01	0.34	1.32	0.48
Max	89.80	54.50	54.10	2.90	16.00	9.20	11.60	1.40	80.00	0.84	0.88	0.59	1.70	18.30	2.70
Min	88.30	49.40	48.00	0.40	10.00	5.90	8.50	0.80	79.00	0.82	0.86	0.57	0.50	13.40	1.10
CV	0.39	2.50	2.98	49.77	14.01	13.57	8.87	16.63	0.50	0.80	0.80	0.93	37.27	8.13	23.70
Soy Best															
Avg	88.46	46.59	45.26	1.33	4.50	10.89	21.22	7.35	86.50	0.94	1.00	0.69	1.36	11.27	1.90
SD	0.21	1.56	2.00	0.60	1.75	1.58	1.76	0.40	0.92	0.01	0.01	0.01	0.41	1.27	0.60
Max	89.00	48.20	46.90	2.40	7.00	13.30	25.10	8.10	88.00	0.96	1.02	0.70	2.20	13.10	2.60
Min	88.20	43.00	40.70	0.70	2.00	8.30	18.60	6.70	85.00	0.92	0.98	0.67	0.70	9.40	0.40
CV	0.23	3.34	4.41	44.87	38.81	14.53	8.28	5.42	1.07	1.35	1.32	1.59	30.17	11.27	31.58
SoyPass															
Avg	89.50	51.95	50.87	1.08	5.30	7.67	21.07	1.84	82.10	0.86	0.91	0.61	1.11	14.60	1.53
SD	0.54	1.12	1.64	0.84	2.28	1.49	2.72	0.45	1.14	0.01	0.01	0.01	0.36	1.54	0.48
Max	90.10	54.60	54.10	3.50	11.00	10.50	25.00	2.90	84.00	0.88	0.93	0.63	1.60	18.20	2.60
Min	88.30	50.40	47.70	0.60	3.00	5.70	16.80	1.50	81.00	0.85	0.89	0.60	0.40	12.90	1.10
CV	0.60	2.16	3.22	78.22	43.07	19.44	12.92	24.45	1.38	1.47	1.50	2.00	32.34	10.53	31.62
SoyPlus															
Avg	89.89	47.96	45.94	2.03	6.60	10.58	20.17	6.14	84.60	0.91	0.97	0.66	1.85	13.95	1.30
SD	1.28	0.86	1.57	1.13	1.74	1.67	1.50	0.20	1.36	0.02	0.02	0.02	0.45	1.73	0.46
Max	92.80	49.70	48.60	4.30	10.00	13.00	23.00	6.50	87.00	0.94	0.99	0.69	2.60	17.30	1.90
Min	89.20	46.70	42.40	0.90	5.00	8.00	18.30	5.90	82.00	0.88	0.93	0.63	1.10	11.80	0.60
CV	1.43	1.80	3.43	55.78	26.42	15.75	7.42	3.19	1.60	1.78	1.87	2.53	24.56	12.38	35.61

Continued

Table 2 (continued). Nutrient composition of feedstuffs (DM basis)

Description	DM	CP	Available CP	Unavailable CP	Soluble protein	ADF	NDF	Crude fat	TDN	NE_l	NE_n	NE_g	Lignin	Sugar	Starch
	%									Mcal/lb			%		
Amin Plus															
Avg	87.36	49.96	48.63	1.35	4.10	8.92	16.08	1.14	80.40	0.84	0.88	0.59	1.16	13.96	1.61
SD	0.43	1.43	1.77	0.57	1.64	1.11	1.47	0.40	1.02	0.01	0.02	0.01	0.53	1.94	0.68
Max	88.30	52.60	52.00	2.30	7.00	10.70	19.50	2.10	82.00	0.85	0.90	0.60	2.10	17.80	2.20
Min	86.70	48.00	46.40	0.60	2.00	6.90	14.30	0.70	78.00	0.81	0.84	0.56	0.50	10.70	0.20
CV	0.49	2.86	3.64	41.94	40.00	12.45	9.17	35.35	1.27	1.35	1.76	1.93	45.49	13.87	42.35
Pro-Lak															
Avg	92.14	79.88	73.27	6.62	12.40	NA	NA	10.10	74.90	0.84	0.89	0.59	6.65	1.38	0.56
SD	0.78	1.99	3.14	2.28	8.58	NA	NA	1.30	2.39	0.03	0.04	0.04	1.73	0.85	0.42
Max	93.40	83.00	80.10	10.20	37.00	NA	NA	13.60	81.00	0.93	1.00	0.69	9.50	2.90	1.50
Min	91.10	76.50	67.20	1.00	7.00	NA	NA	8.80	73.00	0.81	0.85	0.56	4.90	0.00	0.20
CV	0.84	2.50	4.28	34.42	69.20	NA	NA	12.92	3.18	4.16	4.76	6.17	26.01	53.99	76.06
Sea-Lac															
Avg	91.47	70.32	68.83	1.49	10.80	NA	NA	10.31	77.30	0.87	0.92	0.62	1.55	1.90	0.92
SD	1.31	1.40	2.37	1.54	2.82	NA	NA	1.31	2.97	0.04	0.05	0.04	0.45	1.02	0.30
Max	93.90	72.50	71.60	5.90	16.00	NA	NA	11.80	80.00	0.91	0.97	0.66	2.00	4.60	1.50
Min	89.10	68.30	66.90	0.50	7.00	NA	NA	7.20	71.00	0.78	0.81	0.53	1.10	0.90	0.50
CV	1.43	1.99	3.44	103.43	26.12	NA	NA	12.67	3.84	4.67	5.35	6.62	29.03	53.78	32.54
AP301															
Avg	92.49	103.04	101.51	1.54	94.00	NA	NA	NA	69.20	0.72	0.73	0.46	NA	10.26	0.92
SD	0.47	0.85	1.47	0.83	2.19	NA	NA	NA	0.60	0.01	0.01	0.01	NA	0.50	0.30
Max	93.60	104.40	104.20	1.70	97.00	NA	NA	NA	70.00	0.71	0.75	0.47	NA	11.10	1.40
Min	91.90	101.40	99.70	0.20	91.00	NA	NA	NA	68.00	0.71	0.73	0.45	NA	9.50	0.40
CV	0.51	0.82	1.45	54.19	2.33	NA	NA	NA	0.87	0.89	1.07	1.68	NA	4.89	32.54
Bakery															
Avg	87.66	13.24	12.59	0.67	1.10	3.80	6.05	7.76	92.80	1.01	1.09	0.76	1.31	15.72	45.30
SD	1.29	0.96	1.05	0.22	0.54	1.21	1.29	1.33	2.09	0.03	0.04	0.03	0.16	4.59	4.56
Max	89.90	14.80	14.30	1.00	2.00	6.60	8.90	9.50	96.00	1.05	1.13	0.80	1.70	21.70	52.70
Min	86.30	12.20	11.20	0.40	0.00	1.90	4.70	5.90	89.00	0.96	1.02	0.71	1.10	8.90	35.80
CV	1.47	7.23	8.33	32.73	48.96	31.97	21.27	17.10	2.25	2.73	3.27	3.75	12.52	29.22	10.06

[1]Avg = average (mean), Max = maximum, and Min = minimum.

[2]DDG = dried distiller's grains supplied by ADM Processing Co., Decatur, IL.

[3]DDG = dried distiller's grains supplied by Commodity Specialists Co., Minneapolis, MN.

Table 3. Mineral composition of feedstuffs (DM basis)

Description	Ca	P	Mg	K	Na	Fe	Zn	Cu	Mn	Mo	S	Cl	Ash
	%					ppm					%		
Dakota Gold													
Avg[1]	0.05	0.95	0.34	1.13	0.21	101.00	107.80	2.90	15.10	1.05	0.80	0.21	5.77
SD	0.02	0.07	0.02	0.07	0.09	29.10	49.07	1.81	4.28	0.34	0.14	0.02	0.98
Max[1]	0.09	1.03	0.37	1.24	0.36	162.00	208.00	6.00	26.00	1.60	1.00	0.25	8.25
Min[1]	0.02	0.78	0.28	1.00	0.06	67.00	69.00	1.00	11.00	0.60	0.56	0.16	4.80
CV	37.90	7.71	7.10	6.59	45.44	28.81	45.52	62.55	28.32	32.51	17.00	12.20	16.91
DDG-ADM[2]													
Avg	0.50	0.93	0.34	1.18	0.74	216.80	52.00	6.90	27.10	1.23	0.83	0.49	7.74
SD	0.10	0.08	0.04	0.05	0.22	47.46	5.00	2.51	5.89	0.08	0.08	0.46	1.02
Max	0.65	1.05	0.41	1.24	1.06	331.00	62.00	12.00	36.00	1.30	0.88	1.85	9.61
Min	0.37	0.83	0.28	1.11	0.30	160.00	47.00	2.00	19.00	1.10	0.62	0.29	5.99
CV	19.83	8.20	12.68	3.91	29.87	21.89	9.62	36.35	21.73	6.77	9.71	92.72	13.17
DDG[3]													
Avg	0.05	0.95	0.37	1.18	0.15	86.90	55.60	4.80	14.50	1.13	0.78	0.35	7.18
SD	0.01	0.06	0.04	0.08	0.08	14.11	6.67	2.68	1.75	0.09	0.13	0.44	0.75
Max	0.07	1.04	0.41	1.34	0.33	101.00	66.00	10.00	16.00	1.20	0.88	1.66	8.20
Min	0.04	0.86	0.31	1.02	0.08	58.00	47.00	1.00	11.00	1.00	0.41	0.18	5.39
CV	17.89	6.12	10.34	6.54	50.27	16.24	11.99	55.75	12.04	7.80	17.03	126.71	10.48
Soybean meal													
Avg	0.60	0.81	0.29	2.44	0.00	130.40	45.30	14.80	33.80	3.16	0.43	0.08	7.35
SD	0.10	0.03	0.02	0.05	0.00	75.29	2.57	2.86	1.66	0.36	0.02	0.04	0.26
Max	0.71	0.84	0.35	2.50	0.01	351.00	49.00	22.00	37.00	3.90	0.48	0.15	7.78
Min	0.44	0.75	0.26	2.34	0.00	79.00	40.00	12.00	30.00	2.70	0.40	0.00	6.99
CV	16.12	3.19	8.22	2.01	61.90	57.73	5.68	19.30	4.92	11.51	5.29	52.29	3.49
Soy Best													
Avg	0.44	0.73	0.31	2.29	0.03	174.90	46.60	13.40	37.00	2.50	0.41	0.06	7.08
SD	0.03	0.02	0.01	0.14	0.03	55.36	1.28	1.02	2.45	0.50	0.02	0.05	0.37
Max	0.50	0.75	0.32	2.53	0.07	321.00	50.00	16.00	42.00	3.70	0.43	0.19	7.60
Min	0.39	0.68	0.29	2.08	0.00	126.00	46.00	12.00	33.00	1.70	0.37	0.02	6.41
CV	6.92	2.56	3.33	6.28	109.79	31.65	2.75	7.61	6.62	19.92	5.09	84.39	5.27
SoyPass													
Avg	0.39	0.82	0.32	2.41	0.01	136.40	46.60	15.60	32.70	1.83	0.40	0.09	6.53
SD	0.02	0.04	0.01	0.17	0.00	21.18	1.80	1.02	1.79	0.20	0.03	0.14	0.09
Max	0.42	0.86	0.33	2.61	0.01	175.00	49.00	17.00	36.00	2.30	0.43	0.14	6.65
Min	0.36	0.76	0.30	2.19	0.00	109.00	43.00	13.00	30.00	1.60	0.34	0.02	6.30
CV	4.59	4.60	3.15	7.15	67.89	15.53	3.86	6.54	5.48	10.67	6.53	154.24	1.40
SoyPlus													
Avg	0.43	0.75	0.32	2.20	0.00	104.50	41.00	12.30	31.20	2.01	0.39	0.05	6.69
SD	0.02	0.03	0.01	0.14	0.00	20.33	3.16	1.90	1.83	0.71	0.03	0.03	0.47
Max	0.46	0.83	0.34	2.56	0.01	150.00	47.00	15.00	34.00	3.90	0.45	0.09	7.53
Min	0.41	0.70	0.29	2.05	0.00	85.00	37.00	10.00	29.00	1.40	0.36	0.02	6.14
CV	3.88	4.37	4.55	6.44	50.70	19.46	7.71	15.45	5.88	35.42	6.83	47.77	7.01
Amino Plus													
Avg	0.50	0.77	0.35	2.56	0.06	142.50	48.70	16.10	39.10	5.26	0.42	0.08	7.55
SD	0.03	0.04	0.03	0.14	0.01	13.95	4.10	2.02	2.12	0.98	0.02	0.04	1.65
Max	0.50	0.81	0.41	2.74	0.07	163.00	58.00	21.00	44.00	6.80	0.45	0.17	12.35
Min	0.46	0.69	0.32	2.29	0.04	114.00	45.00	15.00	37.00	3.70	0.38	0.05	6.71
CV	5.13	5.22	8.75	5.48	14.05	9.79	8.42	12.56	5.42	18.65	5.63	53.29	21.85
Pro-Lak													
Avg	3.48	1.96	0.11	0.43	0.40	915.40	68.20	10.50	16.10	0.35	1.03	0.44	12.32
SD	0.82	0.48	0.03	0.11	0.11	237.48	17.07	3.29	9.89	0.11	0.08	0.08	0.51
Max	4.29	2.18	0.13	0.57	0.47	1,130.00	87.00	14.00	43.00	0.50	1.15	0.50	13.58
Min	1.10	0.56	0.04	0.14	0.11	245.00	20.00	2.00	3.00	0.20	0.89	0.29	11.85
CV	23.60	24.76	22.87	25.88	27.60	25.94	25.03	31.37	61.45	31.94	8.04	18.06	4.15

Continued

Table 3 (continued). Mineral composition of feedstuffs (DM basis)

Description	Ca	P	Mg	K	Na	Fe	Zn	Cu	Mn	Mo	S	Cl	Ash
	%					ppm					%		
Sea-Lac													
Avg	6.09	3.54	0.22	0.88	0.60	1,128.90	138.40	4.70	98.20	0.65	0.92	0.80	22.09
SD	0.55	0.22	0.03	0.20	0.22	329.28	85.74	4.67	119.83	0.28	0.13	0.41	1.33
Max	6.64	3.82	0.30	1.26	1.12	1,920.00	323.00	18.00	455.00	0.90	1.19	1.89	23.94
Min	4.68	3.03	0.19	0.59	0.30	773.00	89.00	1.00	38.00	0.10	0.71	0.36	19.15
CV	9.11	6.09	13.48	22.87	37.49	29.17	61.95	99.36	122.03	43.29	13.64	50.68	6.01
AP301													
Avg	0.01	0.20	0.02	0.51	0.75	2,556.00	14.10	2.70	NA[4]	NA	0.50	0.73	2.78
SD	0.00	0.07	0.01	0.29	0.10	141.86	1.04	0.64	NA	NA	0.03	0.14	0.96
Max	0.02	0.35	0.03	1.08	0.88	2,820.00	16.00	4.00	NA	NA	0.53	0.90	3.98
Min	0.01	0.13	0.01	0.30	0.58	2,260.00	13.00	2.00	NA	NA	0.46	0.39	2.63
CV	35.25	34.20	53.75	56.84	12.68	5.55	7.40	23.72	NA	NA	6.08	18.44	34.55
Bakery													
Avg	0.23	0.22	0.06	0.24	0.70	187.20	18.70	4.10	12.40	0.43	0.18	1.05	3.20
SD	0.04	0.02	0.01	0.03	0.06	93.87	5.97	1.30	4.05	0.15	0.01	0.08	0.37
Max	0.30	0.26	0.09	0.29	0.84	377.00	33.00	7.00	19.00	0.60	0.21	1.25	4.26
Min	0.17	0.21	0.05	0.20	0.64	90.00	13.00	3.00	8.00	0.20	0.17	0.95	2.90
CV	17.69	7.72	18.62	10.89	9.05	50.14	31.91	31.71	32.70	34.57	8.24	8.09	11.50

[1]Avg = average (mean), Max = maximum, and Min = minimum.

[2]DDG = dried distiller's grains supplied by ADM Processing Co., Decatur, IL.

[3]DDG = dried distiller's grains supplied by Commodity Specialists Co., Minneapolis, MN.

[4]NA = not analyzed.

In the AA composition table (Table 4), the CV were low across all ingredients (generally less than 10%). The only exceptions are the total AA analyses of the insoluble fraction for soybean meal where CV were in a fairly narrow range for all AA tested and ran between 12 and 17%. Within the insoluble fraction of soybean meal, the CV were in a fairly narrow range for all AA tested, between 12 and 17%. The overall variability within the AA tables is unexpectedly low in view of the fact that only 3 samples from each BPF were analyzed and that the degree of variability was much higher in other nutrients where more samples were analyzed.

One comparison that is noteworthy is the differences in AA levels between the total composition and the ADICP fraction. In this nutrient group, without exception, the AA levels in the insoluble fraction were higher. One possible explanation is the lab-to-lab difference. As noted earlier, total AA analysis was performed by Degussa Corp., and analysis of the insoluble fraction was done by Novus International. It may also indicate a higher extraction procedure, but the initial concentration of AA is very low so small differences may be accentuated. It is possible that during the extraction procedure that soluble protein, carbohydrates, and minerals are washed out, resulting in slightly higher CP in the insoluble fraction.

In the tables showing disappearance rates and intestinal digestibilities (Table 5), there was a wide range of CV in disappearance rates. There are several factors that could contribute to this. Only 3 samples from each BPF group were analyzed, so variation among the 3 could easily influence the variability. For each BPF sample, analysis was done in triplicate of 5 g each. The small quantities could also have a noticeable impact on variation. As discussed before, variations between samples can be magnified where the absolute value of the nutrient is relatively small.

Coefficients of variation for intestinal digestibilities were also within a satisfactory range for comparing the variability of feedstuffs. All coefficients were less than 10% with one exception (11.9% CV for intestinal digestion of sample in Pro-Lak). Based on the amount of variation in other nutrients and disappearance rate, a higher degree of variability would be expected.

Distillers Products

Ethanol production in the United States is expanding substantially and is expected to double in the next several years, according to the University of Minnesota website on distillers grains by-products (http://www.ddgs.umn.edu). As fossil fuel prices continue to rise, ethanol may become a more economical alternative to meet our national energy demands. This will inevitably lead to more distillers products available for livestock and poultry feeding. The 3

Table 4. Total amino acid composition[1] (%) and amino acid composition of the acid insoluble nitrogen fraction[2] (g amino acid/100g) of feedstuffs (as-received basis)

Description	Arg	Cys	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Gly	Pro	Ala	Asp	Glu
Dakota Gold															
Degussa															
Avg[3]	1.17	0.46	0.69	1.01	3.32	0.67	0.53	1.41	1.04	1.31	1.06	2.17	1.99	1.83	4.87
SD	0.09	0.05	0.07	0.09	0.36	0.08	0.06	0.14	0.09	0.11	0.09	0.19	0.19	0.15	0.55
CV	7.57	10.31	9.75	8.59	10.87	12.39	12.10	10.08	8.88	8.53	8.85	8.72	9.51	8.18	11.22
Novus															
Avg	1.39	0.62	0.88	1.34	4.37	0.85	0.68	1.86	1.24	1.78	1.21	2.77	2.51	2.15	5.59
SD	0.07	0.04	0.06	0.11	0.24	0.10	0.04	0.13	0.02	0.14	0.06	0.17	0.22	0.03	0.27
CV	4.72	6.48	6.97	8.41	5.49	12.28	5.88	6.78	1.67	7.60	4.69	6.03	8.60	1.23	4.79
DDG-ADM[4]															
Degussa															
Avg	1.12	0.47	0.67	0.98	3.14	0.66	0.53	1.32	1.00	1.26	1.04	2.06	1.92	1.76	4.70
SD	0.03	0.01	0.02	0.04	0.06	0.03	0.03	0.02	0.05	0.07	0.05	0.03	0.05	0.08	0.10
CV	2.74	2.92	2.43	3.61	1.97	4.17	5.90	1.87	4.61	5.39	4.69	1.24	2.60	4.32	2.20
Novus															
Avg	1.52	0.66	0.93	1.37	4.55	0.90	0.75	1.89	1.34	1.92	1.33	2.73	2.70	2.34	6.03
SD	0.02	0.01	0.01	0.02	0.02	0.03	0.02	0.03	0.03	0.06	0.02	0.08	0.03	0.04	0.10
CV	1.37	1.74	1.08	1.12	0.34	2.94	2.05	1.61	2.39	3.34	1.15	2.77	0.93	1.54	1.64
DDG[5]															
Degussa															
Avg	1.23	0.48	0.71	1.05	3.36	0.72	0.55	1.43	1.08	1.39	1.13	2.16	2.05	1.90	4.91
SD	0.03	0.01	0.01	0.01	0.03	0.04	0.01	0.02	0.02	0.02	0.01	0.05	0.02	0.02	0.04
CV	2.14	2.06	1.66	1.03	1.02	5.41	2.44	1.39	1.39	1.12	0.82	2.17	1.17	0.99	0.85
Novus															
Avg	1.37	0.65	0.87	1.27	4.18	0.80	0.74	1.73	1.25	1.71	1.24	2.74	2.51	2.20	5.62
SD	0.08	0.04	0.06	0.06	0.21	0.04	0.05	0.09	0.08	0.11	0.10	0.16	0.15	0.09	0.28
CV	5.96	5.85	6.99	4.35	5.02	5.00	6.76	4.94	6.40	6.51	8.14	5.69	6.13	4.12	4.97
Soybean meal															
Degussa															
Avg	3.45	0.69	1.24	2.10	3.61	2.93	0.64	2.25	1.89	2.16	2.01	2.43	2.03	5.51	8.62
SD	0.00	0.01	0.01	0.02	0.02	0.01	0.02	0.03	0.02	0.05	0.01	0.02	0.02	0.03	0.03
CV	0.10	1.67	0.97	1.05	0.64	0.42	2.50	1.22	1.18	2.10	0.64	0.80	0.91	0.60	0.32
Novus															
Avg	3.19	0.66	1.23	2.18	3.61	2.92	0.61	2.38	1.81	2.33	1.92	2.35	2.04	4.72	7.50
SD	0.53	0.11	0.18	0.35	0.54	0.45	0.08	0.37	0.27	0.37	0.28	0.37	0.30	0.74	1.25
CV	16.61	17.23	14.37	15.87	15.10	15.27	12.68	15.77	14.82	15.76	14.71	15.97	14.53	15.59	16.68
Soy Best															
Degussa															
Avg	2.97	0.57	1.07	1.85	3.17	2.40	0.57	1.91	1.69	1.91	1.80	2.17	1.79	4.80	7.46
SD	0.02	0.00	0.01	0.03	0.03	0.01	0.02	0.05	0.02	0.01	0.02	0.04	0.01	0.04	0.07
CV	0.53	0.54	1.00	1.42	0.89	0.54	3.26	2.41	0.90	0.54	1.20	1.75	0.83	0.88	0.92
Novus															
Avg	2.72	0.56	1.01	1.87	3.08	2.32	0.51	2.05	1.55	1.97	1.70	2.01	1.78	4.19	6.59
SD	0.30	0.06	0.08	0.19	0.30	0.22	0.01	0.21	0.13	0.18	0.16	0.22	0.16	0.39	0.83
CV	10.93	10.16	8.37	10.19	9.87	9.45	2.77	10.00	8.69	8.96	9.59	10.92	8.74	9.28	12.56
SoyPass															
Degussa															
Avg	3.20	0.64	1.19	2.14	3.67	2.30	0.64	2.30	1.93	2.16	2.03	2.48	2.03	5.61	8.83
SD	0.05	0.00	0.01	0.02	0.02	0.02	0.00	0.02	0.01	0.03	0.01	0.04	0.01	0.03	0.05
CV	1.60	0.49	0.81	1.01	0.52	0.96	0.49	1.03	0.37	1.17	0.54	1.64	0.58	0.52	0.52
Novus															
Avg	4.00	0.83	1.57	2.75	4.90	2.96	0.89	3.18	2.42	2.92	2.55	3.06	2.80	6.95	10.72
SD	0.18	0.00	0.04	0.03	0.08	0.21	0.00	0.05	0.02	0.04	0.02	0.04	0.03	0.11	0.18
CV	4.60	0.00	2.71	1.03	1.59	7.17	0.00	1.55	0.88	1.21	0.83	1.15	1.01	1.53	1.65

Continued

Table 4 (continued). Total amino acid composition[1] (%) and amino acid composition of the acid insoluble nitrogen fraction[2] (g amino acid/100g) of feedstuffs (as-received basis)

Description	Arg	Cys	His	Ile	Leu	Lys	Met	Phe	Thr	Val	Gly	Pro	Ala	Asp	Glu
SoyPlus															
Degussa															
Avg	3.15	0.58	1.14	1.97	3.40	2.52	0.60	2.07	1.78	2.02	1.91	2.30	1.89	5.13	8.05
SD	0.03	0.01	0.01	0.01	0.02	0.03	0.00	0.02	0.02	0.03	0.01	0.02	0.01	0.03	0.03
CV	1.09	1.87	0.67	0.36	0.45	1.16	0.35	0.86	0.86	1.33	0.28	0.88	0.29	0.53	0.38
Novus															
Avg	3.63	0.70	1.40	2.39	4.21	3.01	0.73	2.74	2.11	2.52	2.23	2.61	2.37	5.79	9.06
SD	0.01	0.00	0.01	0.06	0.01	0.01	0.01	0.04	0.06	0.11	0.00	0.06	0.11	0.11	0.16
CV	0.39	0.00	0.51	2.66	0.17	0.47	1.93	1.29	3.02	4.20	0.00	2.16	4.48	1.83	1.80
Amino Plus															
Degussa															
Avg	3.27	0.65	1.18	2.05	3.52	2.68	0.65	2.16	1.87	2.09	1.99	2.38	1.97	5.38	8.37
SD	0.05	0.02	0.02	0.03	0.03	0.03	0.01	0.05	0.01	0.05	0.03	0.05	0.02	0.06	0.08
CV	1.49	2.50	1.38	1.55	0.97	0.99	1.61	2.52	0.56	2.48	1.35	2.05	0.78	1.11	0.91
Novus															
Avg	4.26	0.86	1.62	2.84	4.85	3.64	0.88	3.18	2.37	3.00	2.54	3.05	2.79	6.70	10.37
SD	0.10	0.05	0.03	0.04	0.16	0.05	0.09	0.08	0.05	0.05	0.04	0.04	0.14	0.40	0.22
CV	2.45	5.76	1.63	1.41	3.24	1.41	9.76	2.38	2.19	1.76	1.57	1.32	4.90	5.94	2.07
Pro-Lak															
Degussa															
Avg	4.25	1.32	2.20	2.34	6.40	4.43	1.08	3.69	3.14	4.50	5.46	4.63	4.76	6.13	7.86
SD	0.15	0.13	0.11	0.38	0.31	0.09	0.02	0.20	0.01	0.29	0.19	0.17	0.13	0.19	0.17
CV	3.44	9.63	4.92	16.06	4.83	1.99	1.55	5.48	0.32	6.35	3.46	3.61	2.75	3.06	2.19
Novus															
Avg	4.51	1.71	2.36	2.42	6.88	4.75	1.13	3.99	3.20	5.05	5.32	4.84	4.89	6.16	7.77
SD	0.27	0.17	0.17	0.46	0.38	0.21	0.06	0.23	0.06	0.39	0.40	0.24	0.28	0.47	0.47
CV	5.91	10.15	7.05	19.15	5.46	4.46	5.38	5.88	1.72	7.74	7.50	4.86	5.65	7.55	5.99
Sea-Lac															
Degussa															
Avg	3.81	0.50	1.51	2.48	4.47	4.93	1.78	2.44	2.60	2.89	4.67	2.90	4.01	5.86	8.41
SD	0.09	0.01	0.13	0.05	0.13	0.16	0.05	0.08	0.07	0.07	0.16	0.10	0.12	0.15	0.20
CV	2.38	2.00	8.76	2.02	2.81	3.22	2.83	3.29	2.50	2.55	3.47	3.33	2.88	2.56	2.32
Novus															
Avg	4.08	0.56	1.54	2.81	4.77	5.30	1.83	2.67	2.69	3.24	4.23	2.97	3.91	5.69	8.45
SD	0.04	0.04	0.02	0.02	0.01	0.07	0.04	0.01	0.02	0.02	0.14	0.08	0.03	0.02	0.14
CV	0.93	7.17	0.99	0.54	0.24	1.32	2.07	0.43	0.64	0.71	3.34	2.54	0.74	0.37	1.68
AP301															
Degussa															
Avg	3.10	0.44	5.59	0.35	10.95	7.42	0.87	6.00	3.26	7.24	3.68	2.77	6.80	9.01	6.56
SD	0.36	0.08	0.68	0.11	0.96	0.50	0.21	0.42	0.38	0.55	0.42	0.20	0.52	1.12	0.61
CV	11.70	18.64	12.15	31.19	8.78	6.78	23.81	7.09	11.65	7.59	11.46	7.06	7.61	12.41	9.27
Novus															
Avg	NA[6]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bakery															
Degussa															
Avg	0.47	0.26	0.26	0.43	0.88	0.23	0.18	0.61	0.35	0.50	0.45	1.32	0.41	0.56	3.87
SD	0.04	0.02	0.02	0.03	0.05	0.02	0.01	0.04	0.02	0.03	0.03	0.11	0.02	0.03	0.32
CV	7.75	6.63	6.63	7.53	5.76	9.91	6.20	6.59	6.51	6.57	6.29	8.18	4.64	4.75	8.30
Novus															
Avg	0.56	0.28	0.31	0.50	1.08	0.27	0.25	0.74	0.40	0.59	0.52	1.49	0.52	0.66	4.32
SD	0.04	0.00	0.01	0.05	0.07	0.04	0.00	0.03	0.01	0.06	0.02	0.01	0.04	0.05	0.04
CV	6.37	0.00	4.56	10.00	6.55	13.34	0.00	3.82	1.79	10.88	4.12	0.95	6.87	7.56	0.98

[1]Analyzed by Degussa Corp., Kennesaw, GA.

[2]Analyzed by Novus Int. (St. Louis, MO).

[3]Avg = average (mean).

[4]DDG = dried distiller's grains supplied by ADM Processing Co. (Decatur, IL).

[5]DDG = dried distiller's grains supplied by Commodity Specialists Co., Minneapolis, MN.

[6]NA = not analyzed.

Table 5. Intestinal digestibility and disappearance rates for feedstuffs (DM basis)

Description	4 h	8 h	16 h	30 h	48 h	A[1]	B1[1]	B1[2]	B2[1]	B2[2]	C[1]	CP	PRIP[3]	ID[4]
	%							%/h	%	%/h	%	%		
Dakota Gold														
DM														
Avg[5]	46.15	56.72	64.62	72.27	83.55	0.00	49.68	48.37	50.32	2.18	0.00	29.93	40.90	80.6
SD	0.49	0.50	3.54	4.36	1.01	0.00	3.66	11.27	3.66	0.02	0.00	2.30	2.52	4.2
CV	1.06	0.89	5.48	6.03	1.21	0.00	7.36	23.29	7.27	0.92	0.00	7.69	6.17	5.2
NDF														
Avg	23.76	39.21	51.61	62.73	79.76	0.00	69.76	2.35	30.24	24.85	0.00	—	—	—
SD	1.96	1.82	2.43	2.08	4.92	0.00	7.18	0.41	7.18	6.06	0.00	—	—	—
CV	8.24	4.64	4.70	3.32	6.17	0.00	10.29	17.58	23.73	24.39	0.00	—	—	—
Protein														
Avg	33.02	44.50	55.12	62.46	73.93	10.53	52.63	3.12	24.69	25.35	12.16	—	—	—
SD	1.67	3.08	5.61	5.64	0.96	18.23	15.99	2.05	25.34	26.68	11.80	—	—	—
CV	5.05	6.93	10.18	9.03	1.30	173.21	30.38	65.74	102.64	105.26	97.04	—	—	—
DDG-ADM[6]														
DM														
Avg	39.66	49.54	56.18	67.96	82.36	0.00	63.13	25.39	36.87	39.83	0.00	29.23	41.80	71.9
SD	11.39	9.77	9.15	5.82	5.00	0.00	11.24	39.83	11.24	34.02	0.00	0.81	0.75	3.2
CV	28.71	19.72	16.28	8.57	6.07	0.00	17.80	156.89	30.48	85.40	0.00	2.76	1.81	4.4
NDF														
Avg	3.99	15.15	28.92	47.89	73.28	0.73	84.34	2.36	14.93	1.00	0.00	—	—	—
SD	6.50	11.41	10.02	7.72	7.02	1.26	27.13	0.61	25.86	1.74	0.00	—	—	—
CV	162.92	75.31	34.66	16.13	9.59	173.21	32.16	25.72	173.21	173.21	0.00	—	—	—
Protein														
Avg	25.52	31.07	38.68	51.58	67.66	5.07	68.44	43.50	26.49	108.36	0.00	—	—	—
SD	11.04	12.46	11.50	9.22	9.58	8.79	30.78	72.52	35.68	185.85	0.00	—	—	—
CV	43.26	40.10	29.74	17.88	14.16	173.21	44.97	166.70	134.73	171.52	0.00	—	—	—
DDG[7]														
DM														
Avg	36.34	44.82	53.01	63.75	80.30	0.00	67.56	2.34	32.44	82.74	0.00	30.87	43.20	72.0
SD	4.43	5.20	6.80	4.91	3.99	0.00	6.44	0.16	6.44	31.38	0.00	0.23	2.34	0.5
CV	12.19	11.61	12.83	7.70	4.97	0.00	9.53	6.75	19.84	37.93	0.00	0.75	5.42	0.7
NDF														
Avg	1.36	12.77	28.51	44.86	74.07	0.00	85.49	2.27	14.51	0.88	0.00	—	—	—
SD	1.27	8.63	9.01	5.97	4.75	0.00	25.12	0.41	25.12	1.53	0.00	—	—	—
CV	93.45	67.57	31.59	13.31	6.42	0.00	29.39	17.97	173.21	173.21	0.00	—	—	—
Protein														
Avg	18.85	26.64	33.98	48.82	64.88	7.55	38.12	50.78	54.33	1.39	0.00	—	—	—
SD	5.50	5.05	9.68	1.87	6.54	8.21	20.21	83.50	26.85	0.52	0.00	—	—	—
CV	29.15	18.96	28.49	3.83	10.07	108.77	53.03	164.43	49.42	37.68	0.00	—	—	—
Soybean meal														
DM														
Avg	66.99	74.66	93.39	99.19	97.96	19.19	19.17	121.66	61.64	14.06	0.00	NA[8]	NA	NA
SD	2.86	13.00	1.78	0.47	0.56	23.53	17.63	137.42	9.58	7.38	0.00	—	—	—
CV	4.27	17.41	1.91	0.48	0.58	122.60	91.97	112.95	15.55	52.48	0.00	—	—	—
NDF														
Avg	56.29	72.12	75.25	97.05	92.34	18.44	38.04	26.70	42.38	4.98	1.14	—	—	—
SD	11.16	15.41	5.06	1.51	1.79	31.94	43.22	24.71	26.34	3.16	1.98	—	—	—
CV	19.83	21.37	6.72	1.56	1.94	173.21	113.62	92.54	62.15	63.39	173.21	—	—	—
Protein														
Avg	57.64	66.64	92.29	99.06	97.62	19.17	25.63	33.75	54.56	11.26	0.64	—	—	—
SD	5.13	16.82	2.34	0.58	0.73	10.88	44.40	49.35	48.17	12.33	1.11	—	—	—
CV	8.90	25.24	2.53	0.58	0.75	56.74	173.21	146.23	88.29	109.47	173.21	—	—	—

Continued

Table 5 (continued). Intestinal digestibility and disappearance rates for feedstuffs (DM basis)

Description	4 h	8 h	16 h	30 h	48 h	A[1]	B1[1]	B1[2]	B2[1]	B2[2]	C[1]	CP	PRIP[3]	ID[4]
	%							%/h	%	%/h	%	%		
SoyBest														
DM														
Avg	54.61	67.03	80.22	87.84	96.67	5.76	41.06	62.54	51.53	6.46	1.65	46.47	72.83	83.87
SD	2.90	4.58	2.43	1.14	0.34	3.48	1.24	14.95	1.33	2.17	2.86	0.58	2.47	1.55
CV	5.31	6.83	3.03	1.30	0.35	60.41	3.02	23.90	2.58	33.64	173.21	1.24	3.39	1.85
NDF														
Avg	38.13	56.05	68.38	71.28	94.55	0.00	43.32	40.22	56.68	3.33	0.00	—	—	—
SD	7.86	2.83	3.34	8.49	3.65	0.00	9.63	18.31	9.63	0.99	0.00	—	—	—
CV	20.60	5.06	4.89	11.91	3.86	0.00	22.23	45.54	16.99	29.86	0.00	—	—	—
Protein														
Avg	36.59	49.79	69.85	81.05	94.82	12.74	36.63	12.96	50.62	4.39	0.00	—	—	—
SD	3.65	7.67	4.14	1.88	0.32	11.50	14.35	10.81	3.42	0.41	0.00	—	—	—
CV	9.98	15.41	5.93	2.32	0.34	90.24	39.16	83.47	6.75	9.42	0.00		—	—
SoyPass														
DM														
Avg	33.62	40.80	53.30	77.64	89.74	0.00	19.83	233.70	80.17	3.95	0.00	54.37	83.87	68.20
SD	0.37	2.78	4.69	5.59	1.78	0.00	3.93	115.28	3.93	0.35	0.00	1.08	1.29	1.01
CV	1.10	6.81	8.79	7.21	1.98	0.00	19.80	49.33	4.90	8.93	0.00	1.98	1.53	1.49
NDF														
Avg	16.60	20.78	36.51	60.45	71.72	1.08	65.19	2.64	33.73	62.26	0.00	—	—	—
SD	2.60	3.15	5.17	10.16	2.51	1.87	19.47	0.51	18.44	102.79	0.00	—	—	—
CV	15.68	15.18	14.15	16.82	3.50	173.21	29.87	19.12	54.67	165.09	0.00	—	—	—
Protein														
Avg	12.45	16.92	27.99	63.39	82.08	0.32	99.68	2.96	0.00	0.00	0.00	—	—	—
SD	1.19	4.04	8.07	8.30	2.30	0.56	0.56	0.07	0.00	0.00	0.00	—	—	—
CV	9.52	23.90	28.83	13.09	2.81	173.21	0.56	2.49	0.00	0.00	0.00	—	—	—
SoyPlus														
DM														
Avg	47.20	60.03	72.65	83.12	92.35	6.24	41.70	47.04	52.05	3.96	0.00	48.20	76.17	81.77
SD	4.19	1.53	2.69	3.74	2.22	5.41	8.35	23.09	3.93	0.97	0.00	0.70	0.32	2.45
CV	8.88	2.56	3.70	4.50	2.40	86.61	20.02	49.09	7.56	24.55	0.00	1.45	0.42	3.00
NDF														
Avg	23.10	39.26	56.33	66.51	81.20	0.00	54.51	13.94	44.94	6.70	0.54	—	—	—
SD	9.23	9.11	4.09	9.06	5.61	0.00	15.73	16.23	16.23	7.66	0.94	—	—	—
CV	39.97	23.20	7.27	13.63	6.90	0.00	28.85	116.43	36.11	114.42	173.21	—	—	—
Protein														
Avg	26.96	38.55	57.41	72.73	87.63	6.00	62.88	3.82	31.12	19.91	0.00	—	—	—
SD	5.74	2.67	5.00	6.07	4.04	10.39	27.58	0.83	17.21	13.86	0.00	—	—	—
CV	21.29	6.93	8.71	8.35	4.60	173.21	43.85	21.70	55.31	69.63	0.00	—	—	—
Amino Plus														
DM														
Avg	35.72	46.87	62.07	89.65	94.99	0.00	16.86	256.01	83.14	5.78	0.00	51.17	78.80	70.80
SD	2.35	7.81	5.84	4.19	3.91	0.00	2.09	75.51	2.09	0.94	0.00	0.55	1.61	2.11
CV	6.59	16.66	9.41	4.68	4.12	0.00	12.39	29.49	2.51	16.18	0.00	1.08	2.04	2.98
NDF														
Avg	7.78	27.11	42.74	67.11	79.97	0.00	76.58	4.20	15.24	1.09	8.18	—	—	—
SD	7.19	12.19	5.20	6.77	15.30	0.00	22.88	0.80	26.39	1.89	14.18	—	—	—
CV	92.44	44.97	12.18	10.09	19.13	0.00	29.88	19.08	173.21	173.21	173.21	—	—	—
Protein														
Avg	16.55	26.00	42.90	82.72	92.48	0.00	68.06	4.57	31.94	2.90	0.00	—	—	—
SD	2.89	10.16	6.59	7.11	6.09	0.00	27.67	0.88	27.67	2.63	0.00	—	—	—
CV	17.47	39.08	15.35	8.59	6.59	0.00	40.65	19.27	86.63	90.78	0.00	—	—	—

Continued

Table 5 (continued). Intestinal digestibility and disappearance rates for feedstuffs (DM basis)

Description	4 h	8 h	16 h	30 h	48 h	A[1]	B1[1]	B1[2]	B2[1]	B2[2]	C[1]	CP	PRIP[3]	ID[4]
	%							%/h	%	%/h		%		
Pro-Lak														
DM														
Avg	28.13	31.09	33.92	39.41	42.57	0.00	59.25	0.10	37.86	28.17	2.88	80.67	78.57	50.87
SD	4.96	4.06	4.42	4.90	2.59	0.00	4.83	0.08	1.89	9.77	5.00	1.19	2.97	6.03
CV	17.64	13.05	13.03	12.42	6.08	0.00	8.15	74.75	5.00	34.67	173.21	1.48	3.78	11.86
NDF														
Avg	16.49	19.09	23.23	29.29	38.13	3.03	59.74	0.51	23.80	27.30	13.43	—	—	—
SD	14.47	14.60	12.87	11.50	10.16	4.04	28.94	0.45	20.82	45.33	11.90	—	—	—
CV	87.79	76.47	55.38	39.27	26.64	133.32	48.44	88.08	87.45	166.08	88.62	—	—	—
Protein														
Avg	26.83	32.50	34.55	39.27	43.88	0.00	60.33	0.28	34.67	40.38	5.00	—	—	—
SD	6.42	2.26	5.14	5.99	2.51	0.00	12.44	0.23	7.63	21.32	5.08	—	—	—
CV	23.92	6.95	14.88	15.25	5.72	0.00	20.62	82.67	22.02	52.79	101.56	—	—	—
Sea-Lac														
DM														
Avg	36.30	38.48	43.08	51.53	61.09	0.00	61.36	1.30	32.60	240.03	6.04	70.87	64.40	73.17
SD	2.94	1.90	1.59	0.73	2.49	0.00	7.89	0.32	2.58	108.11	10.47	1.40	2.89	3.06
CV	8.11	4.93	3.70	1.41	4.07	0.00	12.85	24.49	7.93	45.04	173.21	1.98	4.49	4.18
NDF														
Avg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	—	—	—
SD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	—	—	—
CV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	—	—	—
Protein														
Avg	37.68	40.09	43.71	56.09	69.56	0.00	68.20	1.54	31.80	480.24	0.00	—	—	—
SD	2.78	0.90	0.84	2.93	2.09	0.00	2.13	0.11	2.13	202.50	0.00	—	—	—
CV	7.38	2.25	1.93	5.23	3.01	0.00	3.12	7.21	6.70	42.17	0.00	—	—	—
AP301														
DM														
Avg	81.66	74.35	85.57	84.75	90.66	0.00	46.33	333,561.57	39.30	61,003.48	14.37	NA	NA	NA
SD	11.91	10.82	9.17	7.43	9.06	0.00	8.51	445,330.46	12.75	82,016.50	6.33	—	—	—
CV	14.59	14.56	10.72	8.76	9.99	0.00	18.36	133.51	32.44	134.45	44.08	—	—	—
NDF														
Avg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	—	—	—
SD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	—	—	—
CV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	—	—	—
Protein														
Avg	82.03	74.81	85.88	85.38	90.98	0.04	48.81	358,778.77	37.75	65,550.91	13.40	—	—	—
SD	12.17	11.14	9.20	7.68	8.89	0.07	12.47	457,045.23	16.17	84,309.54	5.94	—		—
CV	14.84	14.89	10.71	9.00	9.77	173.21	25.55	127.39	42.82	128.62	44.36	—	—	—
Bakery														
DM														
Avg	82.35	89.78	93.08	98.11	98.50	18.15	20.95	9.25	60.05	355.78	0.85	NA	NA	NA
SD	3.28	1.44	1.74	0.34	0.82	15.73	3.22	3.06	18.24	417.53	0.88	—	—	—
CV	3.98	1.61	1.87	0.35	0.83	86.64	15.36	33.14	30.37	117.36	104.13	—	—	—
NDF														
Avg	0.00	12.14	31.57	87.84	91.63	0.00	84.96	3.79	15.04	1.26	0.00	—	—	—
SD	0.00	10.04	15.32	11.36	10.29	0.00	26.06	0.03	26.06	2.17	0.00	—	—	—
CV	0.00	82.71	48.54	12.93	11.23	0.00	30.67	0.70	173.21	173.21	0.00	—	—	—
Protein														
Avg	49.55	63.11	74.16	95.68	97.93	26.25	20.16	32.74	52.93	7.27	0.65	—	—	—
SD	8.03	4.20	6.44	0.90	2.30	16.19	20.67	50.60	17.64	0.43	1.13	—	—	—
CV	16.21	6.65	8.69	0.94	2.35	61.69	102.50	154.58	33.33	5.93	173.21	—	—	—

[1]A = rapid rate rumen degraded nutrient fraction; B = intramuscular rate rumen degraded nutrient fraction; C = rumen indigestible or low digestible nutrient fraction; Tedeschi et al., 2000. (% of nutrient).

[2]Rate, %/h.

[3]PRIP = post rumen incubation protein.

[4]ID = intestinal digestion of sample.

[5]Avg = average (mean).

[6]DDG = dried distiller's grains supplied by ADM Processing Co. (Decatur, IL).

[7]DDG = dried distiller's grains supplied by Commodity Specialists Co., Minneapolis, MN.

[8]NA = not analyzed.

distillers products evaluated (sourced from Dakota Gold, ADM, and Commodity Specialists Co.) had average CP levels ranging from 31.0 to 32.3%. Coefficients of variation were relatively low for most major parameters measured. Coefficients of variation were high, however, for unavailable CP, soluble protein, lignin, and starch, although the absolute values of these parameters were low. In mineral composition, some variability was also observed.

In situ digestibility was measured at 4, 8, 16, 30, and 48 h. Coefficients of variation were relatively low with a few values higher. Because only 3 samples were used in each group of BPF, this could result in a higher degree of variability than a larger sample set. The highest degree of variability among the BPF tested was seen within distillers products. One possible explanation is the difference in the manufacturing process among the ethanol plants. Intestinal digestibilities were similar in each of the BPF in this group.

Soy Products

Soybean meal is one of the most widely used protein sources in a variety of livestock, dairy, and poultry diets. Soybean meal is also an important component in a number of fortified protein supplements, utilizing soybean meal as their major ingredient. Soybean meal samples for the study were from sources producing a high protein, dehulled product with a minimum guarantee of 47% CP. The sources of this commodity were generic and unknown.

Four soybean meal-based value-added, bypass ingredients were analyzed. Soy Best is an all natural, mechanical extraction process soybean meal. It also contains lecithin, phosphatidylcholine, and other phospholipids, which are added under non-ambient conditions through a proprietary process. SoyPass is produced from 48% high protein soybean meal which is combined with an all-natural highly reactive sugar and heated to 205°F for approximately 40 min. The sugar and the mechanical manufacturing process allow a nonenzymatic browning (Maillard reaction) to take place. The objective of the chemical reaction is to lower rumen degradability to increase the bypass value of the product to approximately 74% without losing overall digestibility. SoyPlus is different than the other 2 products in this group because the raw material is soybeans and not soybean meal. The processing is chemical-free. The beans are processed using a modified expeller extraction along with heat; the final product is the result of both pressure and temperature. Nutrient composition of the products in this group is similar, with SoyPass being lower in fat content than the other 2 products. Several differences are observed in protein disappearance and intestinal digestibility; however, this could be attributed to raw materials used and the difference in processing techniques. Amino Plus is also a soybean-based ingredient used to replace other high quality protein sources and provide a source of bypass protein in rations for dairy cattle. The manufacture of this product involves combining high protein soybean meal with a low level of soy hulls as a source of sugars. After adding moisture, it is heated to a high temperature for a long time period, dried, and cooled. The process does not involve any chemical additives.

Soybean meal and Amino Plus were similar in composition, and the products were uniform in composition over the sampling period. In evaluating these products, it is important to note that soybean meal is readily degraded in the rumen, whereas Amino Plus contains a high proportion of bypass protein.

Pro-Lak and Sea-Lac

Pro-Lak is a multi-source marine and animal bypass protein supplement. It is designed for approximately two-thirds of the protein content to bypass rumen degradation. Pro-Lak is used as a replacement for other high protein ingredients and also as a source for rumen bypass protein.

Sea-Lac is produced solely from menhaden fish through a processing technique that incorporates low drying temperatures, removal of soluble protein, and stabilization at the time of manufacture. It is used in dairy diets to replace other high protein ingredients and provide some degree of rumen bypass. Sea-Lac exhibited a higher level of Ca and Mn, contributing to an ash content twice as high as Pro-Lak. Both BPF may also be good sources of Fe.

AP301 and Bakery By-product

AP301 is a high-quality protein product composed of spray-dried animal blood cells. It can be used as a partial or complete replacement ingredient for other protein sources. Variability in composition parameters was low for AP301. Crude protein value for AP301 is over 100%. This is associated with a conversion of N to CP when using the Kjeldahl method. No insoluble protein fraction for AP301 was recovered and therefore no AA data are available.

Dried bakery product is defined by the State of California as “a mixture of bread, cookies, cake, crackers, flours, and dough which has been mechanically separated from non-edible materials, artificially dried and ground. If the product contains more than 3.5% salt, the maximum percentage of salt shall be a part of the name.” The product sampled in the study was manufactured by Recycle to Conserve, Inc. This dried bakery product is a wheat-based product originating from bread and baked goods. It is primarily used as a replacement for corn or hominy in rations of lactating dairy cows.

Variability within the different composition parameters for AP301 and dried bakery product was relatively low. AP301 is readily degraded in the rumen. Dried bakery product exhibited a slower rumen degradation rate.

IMPLICATIONS

Variability in feedstuffs is a greater issue when feeding high-producing dairy cows. Variability in BPF nutrient composition and analysis was found for most of the products tested. When comparing different BPF and the value that they have in formulating rations, it is important to keep in mind that the variability of some products can have a direct effect on the consistency of performance of the animals who are consuming them. The chemical compositions in the present study were, in many cases, different than estimates published in feed tables. Recently, more diets are being balanced for AA content; however, current tabular values for AA are limited primarily because of the cost of analysis. We, as a committee, felt it was important to start building a database of the AA profiles of common feed ingredients and their likely bypass fraction that are fed in the western United States.

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