Composition of Eleven Pig By-Products

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Summary and Implications

The objective of this study was to evaluate 11 pork-based by-products for chemical and mineral composition to potentially serve as ingredients in carviore diets. By-products ranged widely in composition: DM: 26.0-71.2%; OM: 53.0-96.8%; CP: 22.9-79.3%; fat: 22.0-63.2%; CF: 0.3-19.5%; TDF: 0.0-3.4%; GE: 3.7-7.5 kcal/g; ME: 3.23-6.86 kcal/g. This nutrient range provides flexibility for formulation of various diet types. In addition, these by-products also have potential use as enrichment for managed carnivores.

Introduction

Today, approximately 40% of live pig weight harvested for pork products consumed by humans is discarded to rendering facilities. Typical dressing percentages range from 68 to 77%. Since 1927 more than 70% of rendering facilities have closed due to heightened emission and air pollutant regulation by the Environmental Protection Agency. These closures have increased the cost of sending meat by-products to rendering. Swine producers have expressed interest in increasing pork value through value added by-products and continue to look for avenues other than rendering to increase pig value (for example as enrichment devices for use in zoos). Many by-products sent to rendering, including large bones (femur, humerus, heads), snouts, and tails may be high in valuable nutrients and cartilage. Therefore, the objective of this study was to determine the chemical and mineral compositions of 11 pork-based by-products.

Materials and Methods

By-Products: Eleven pork by-products were evaluated for nutritional composition (Table 1).

Sample Preparation: Pork by-products were provided by Sustainable Swine Resources, LLC (Sheboygan Falls, WI). All items were passed twice through a mechanical grinder (Buffalo No. 66BX Enterprise, St. Louis, MO), and then passed twice through a Hobart 52 grinder with a 5-mm die (model number 4046; Hobart Corporation, Troy, OH) for homogenization. Samples were then frozen and freeze dried for 4 days (vacuum/freezer: Uni-Trap by Cenco Model #10-100; vacuum chamber: Virtis Model #10-104-LD). Grinding and freeze-drying were conducted at Iowa State University. After freeze-drying, samples were ground through a 2-mm screen (Wiley mill, model 3383-L10, Thomas Scientific, Swedesboro, NJ) and analyzed for chemical composition.

Analyses: Proximate analyses of all 11 pork-based by-products was conducted as previously described by Iske and others (2016) including dry matter, organic matter, crude protein, fat, gross energy, and crude and total dietary fiber. Protein to fat ratios were calculated by dividing protein concentration by fat concentration in each item. Mineral analysis was determined by Midwest Laboratories [(Omaha, NE) ((Method 985.01); (MWL ME PROC 29)] (Table 2). Metabolizable energy was calculated using Atwater values (9 kcal/g fat, 4 kcal/g protein, 4 kcal/g carbohydrate) multiplied by fat, protein, and carbohydrate content. Chemical analyses were conducted at Omaha's Henry Doorly Zoo and Aquarium unless otherwise noted.

Results and Discussion

Results: Up to two-fold differences were seen in DM, OM, CP, and fat among the 11 by-products. Heads and lower jaws contained 99 and 98% more TDF and CF than the least fibrous parts, respectively. Protein to fat ratios ranged from 0.5 (tails) to 3.6 (snouts). Gross and metabolizable energy ranged widely with the most calorically dense product containing twice as many calories per gram as the least calorically dense product. Similarly, differences of at least 6-fold were seen among all 11 by-products for nearly all minerals (Tables 1 and 2).

Discussion: As expected, nutrient concentrations among by-products were extremely variable.
Animal managers should carefully consider the caloric density as several items contained high concentrations of fat and energy and could contribute to obesity; however, digestibility of the items should be evaluated. Even bone items, contained at least 22% fat, DMB. Protein concentrations ranged from 22.9 to 79.3% for femurs and snouts, respectively. If an animal needs more calories without increasing fat, snouts would be an option because the protein to fat ratio was high (3.6).

Conversely, if increasing caloric intake is desirable without increasing protein (for an animal with kidney problems, for example) tails would be an option because of their low protein to fat ratio (0.5).
The high protein concentration in snouts, feet and ear canals likely comes from high collagen content in those items. Collagen has a unique amino acid composition that is very high in proline and hydroxyproline and lacks tryptophan; therefore, regular consumption of high collagen items may

change overall amino acid profiles of total consumed dietary protein and may alter the biological value of the overall diet.

The Ca:P ratio of 9 pork-based by-products was around 2:1, which is close to nutritional recommendations for felids. The bone items such as femur, humerus, and scapula have potential to increase calcium and phosphorus consumption as they contained on average 12.5% calcium. If a carnivore does consume the bone, this could alter overall calcium to phosphorus ratios and should be carefully considered when formulating diets. These by-products have potential for use as enrichment items, however, an understanding of the potential nutritional impact of using these items as environmental enrichment needs evaluation and should be considered in overall diet formulations if animals consume these evaluated items.

Therefore, in conclusion, if these pork-based by-products were being considered as enrichment items for animals in zoo, animal mangers should consult their zoo nutritional expert on which items would enhance their overall health.

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Table 1. Chemical Composition of Various Pork-Based Enrichment Items (DM basis)[1]

	%							Kcal/g	
Item	**DM**	**OM**	**CP**	**Fat**	**CF**	**TDF**	**Protein: Fat [2]**	**GE**	**ME**
Heads	48.5	60.7	38.4	22.0	13.5	3.44	1.8	4.09	3.52
Snout	26.0	96.8	79.3	22.2	0.3	0.04	3.6	6.21	5.17
Femur	70.8	65.4	22.9	34.6	12.3	2.21	0.7	5.10	4.26
Humerus	71.2	61.6	23.2	31.4	11.4	2.37	0.7	4.72	3.94
Scapula	62.0	53.5	32.7	22.6	10.7	2.84	1.4	3.73	3.34
Ribs	43.1	74.3	41.6	32.2	1.0	1.11	1.3	5.52	4.56
Neck	49.9	63.8	38.4	24.2	1.6	1.63	1.6	4.39	3.71
Feet	48.2	76.6	54.3	23.3	5.2	1.52	2.4	4.85	4.27
Tails	50.2	91.1	29.4	63.2	1.7	2.15	0.5	7.45	6.86
Lower Jaw	60.7	53.0	29.1	22.9	19.5	1.72	1.3	4.15	3.23
Ear Canals	36.4	96.8	58.3	39.0	0.7	1.59	1.5	6.84	5.84

[1] Abbreviations used: DM, Dry matter; OM, organic matter; CP, crude protein; CF, crude fiber; TDF, total dietary fiber; GE, gross energy

[2] Protein:fat ratios were calculated by dividing protein concentration by fat concentration of each item

Table 2. Mineral Composition of Various Pork-Based Enrichment Items (DM Basis)[1]

	DM Basis									
		%						PPM		
Item	**Ca:P Ratio[2]**	**Ca**	**P**	**S**	**K**	**Mg**	**Na**	**Fe**	**Mn[3]**	**Cu**	**Zn**
Heads	2.1	13.7	6.6	0.3	0.3	0.3	0.6	171.1	2.1	3.9	117.7
Snout	3.8	0.2	0.0	0.6	0.6	0.0	0.7	170.2	2.6	5.6	49.7
Femur	2.1	10.6	5.1	0.1	0.1	0.2	0.5	66.5	n.d.	1.3	90.1
Humerus	2.1	11.5	5.6	0.1	0.1	0.2	0.5	32.4	n.d.	1.3	102.2
Scapula	2.1	13.4	6.3	0.2	0.2	0.3	0.6	45.8	n.d.	1.4	102.3
Ribs	2.0	8.7	4.4	0.3	0.6	0.2	0.4	103.3	n.d.	2.4	121.1
Neck	2.1	11.6	5.6	0.2	0.3	0.2	0.5	72.5	n.d.	1.6	115.7
Feet	2.1	8.3	4.0	0.3	0.2	0.1	0.6	97.0	n.d.	1.8	69.8
Tails	1.9	3.0	1.6	0.2	0.3	0.1	0.3	48.9	1.6	3.1	48.3
Lower Jaw	2.1	13.5	6.5	0.2	0.2	0.3	0.6	318.9	3.8	4.1	107.0
Ear Canals	1.3	0.6	0.5	0.41	0.3	0.0	0.5	186.4	1.7	4.3	45.0

[1] Ca, calcium; P, phosphorus; S, sulfur; K, potassium; Mg, magnesium; Na, sodium; Fe, iron; Mn, manganese; Cu, copper; Zn, zinc; PPM, parts per million

[2] Ca:P ratios were calculated by dividing calcium concentration by phosphorus concentration for each item

[3] Reporting limit: 1 PPM