Feed Sampling and Analysis

Quality of ingredients and complete feeds is essential for effective swine nutrition practices. Analyses to monitor the quality of ingredients and feeds on a regular basis help to avoid errors in estimating nutrient content of ingredients and to identify inaccuracies in feed formulation or feed manufacturing. Moreover, chemical analyses of feed ingredients are important to assign nutritional values to feed ingredients. In order to obtain accurate nutrient values for ingredients and feeds, it is essential to conduct appropriate sampling and analysis.

Sampling procedure

For adequate sampling procedure, it is essential to use proper sampling equipment to ensure the collection of a representative sample (Gonçalves et al., 2016).

Bulk

The most common sampling equipment for bulk feeds or feed ingredients is the slotted grain probe (**Figure 1**), which can be manual or automated. The slotted grain probe should be long enough to reach the bottom of the bulk carrier to obtain a representative sample from top to bottom. Samples should be collected from at least 10 evenly-spaced locations in the bulk carrier (**Figure 2**) to be representative of the entire load of feed or feed ingredient (AAFCO, 2017).

Alternatively, a pelican sampler (**Figure 3)** is also commonly used to steam cut samples during loading or unloading of bulk feeds or feed ingredients. Samples should be collected at least 10 times at regular intervals during loading or unloading (AAFCO, 2017).

In either sampling procedure, the sample size should be at least 1 lb and preferentially 2 lb (AAFCO, 2017).

Bags

The sampling equipment for bagged feeds or ingredients is the bag trier (**Figure 4**). The bag trier should be inserted diagonally in one corner to reach the opposite corner of the bag (**Figure 5)**. At least 10 bags should be collected from the lot, with random selection of bags at varying locations in the lot. The sample size should be at least 1 lb and preferentially 2 lb per bag (AAFCO, 2017).

Liquids

The sampling procedure of liquid ingredients, such as fats, oils, and amino acids, can be performed from bulk, tanks or barrels, or during unloading. The sampling equipment for liquid ingredients in bulk is the bomb sampler and in tanks or barrels is the drum thief sampler. In both cases, liquid ingredients should be stirred before sampling to ensure a proper distribution of nutrients. At least 500 ml or 1 pint of liquid ingredients should be collected from the container (AAFCO, 2017).

Feeders

Samples of complete feed are collected from feeders by probe or hand-grab sampling. Samples collected with a probe have less variability and require fewer number of samples (Jones et al., 2018). Samples should be collected from at least 6 feeders with probe and 9 feeders by hand. Approximately 1 to 2 lb of feed should be collected per feeder and mixed in a composite sample. Creating a composite sample by mixing feed from the sampled feeders is recommended to minimize variability and reduce the number of samples for analysis (Jones et al., 2018).

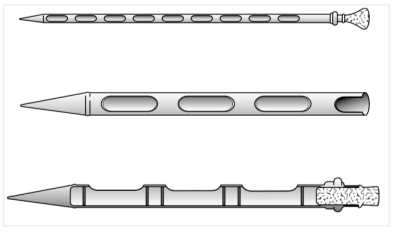

Figure 1. Slotted grain probe (Herrman, 2001)

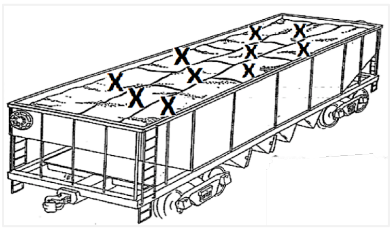

Figure 2. Sampling locations in bulk carriers (AAFCO, 2017)

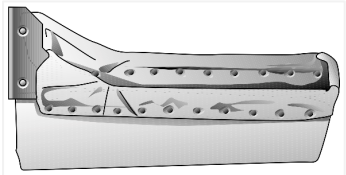

Figure 3. Pelican probe (Herrman, 2001)

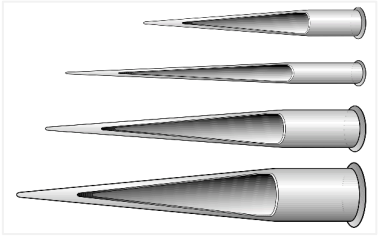

Figure 4. Bag trier (Herrman, 2001)

Figure 5. Bag sampling technique (AFFCO, 2017)

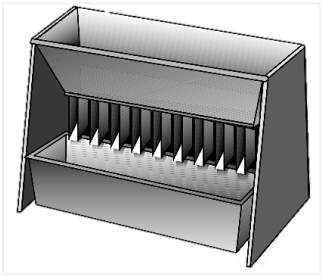

Figure 6. Riffle divider (Herrman, 2001)

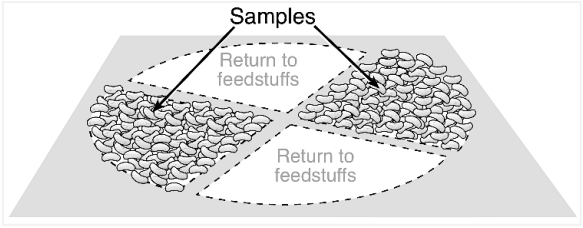

Figure 7. Quartering method (Herrman, 2001)

Preparation of samples for analysis

Sample preparation involves reduction of samples to a suitable size for analysis (Gonçalves et al., 2016). First, composite samples of feeds or ingredients should be mixed thoroughly. Then, samples are split with a riffle divider (**Figure 6**) or by the quartering method (**Figure 7**). The process should yield two samples of approximately 500 g or 1 lb each: one to be submitted for analysis and a second one to be retained as a backup (Herrman, 2001).

Samples for analysis should be placed in plastic or paper bags for submission. Plastic bags are conventionally used, but paper bags are preferred for high-moisture or mold-contaminated samples to prevent condensation of moisture and proliferation of mold growth. Samples should be identified with sample number, date, and content (Herrman, 2001). Labels should not be placed within the bag in contact with the sample (AAFCO, 2017).

Retained samples should be placed in plastic bags, labeled, and immediately frozen for storage. Retained samples should be kept for a predetermined period of time. Usually, the minimum is until feed is consumed by the animals or as long as potential liability exists, e.g. until marketing (Herrman, 2001).

Analysis

The decision on which analyses to perform depends on the individual ingredient and the intended use of the results for either purchasing or diet formulation. In general, analysis of ingredients and feeds often comprises: dry matter (DM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), lysine, calcium, and phosphorus. For analysis of highly variable nutrients like calcium, it is recommended to submit multiple samples for analysis and to analyze samples in duplicates (Jones et al., 2018).

Specific analysis for fat and oil quality or mycotoxin concentration should also be considered in some situations.

A list of commercial laboratories performing analyses of complete feeds and feed ingredients and is shown in **List 1**.

Interpretation of analysis results

The analysis results should be interpreted on as-fed, as-is, or as-received basis, but not on dry-matter basis. These values can then be compared with the expected nutrient specifications of ingredients or with the intended nutrient levels in diet formulation (Reese and Thaler, 2010). The analyzed values generally do not match the expected values perfectly because of normal

variations associated with sampling and laboratory analyses. The errors associated with sampling can be minimized by following the procedures for sample collection described above. The analytical variation is usually taken into consideration to determine acceptability of feeds and ingredients, which is generally around 15 to 25% in most nutrients (AAFCO, 2018) (**Table 1**).

In cases where the analyzed values do not fall within the expected range after considering the analytical variation, it is recommended to submit the retained sample for a repeat analysis. If the analyzed values are consistent between the first and second analysis, there could be an indication of a problem in diet formulation, feed manufacturing, or sampling, or a variation in ingredient quality or nutrient profile.

Table 1. Determination method and analytical variance for analysis of feed ingredients and feeds

Analysis	Determination method[1]	Analytical variance, %[2, 3]	Concentration range[2]
Proximate analysis			
Ash	942.05	(45 ÷ x) +3	2-88%
Fat	920.39, 954.02, 932.02	10	3-20%
Fiber	962.09	(30 ÷ x) + 6	2-30%
Lysine	975.44	20	0.5-4%
Moisture	934.01, 930.15, 935.29	12	3-40%
Protein	954.01, 976.05, 976.06, 984.13	(20 ÷ x) + 2	10-85%
Protein, pepsin digest	971.09	13	
Protein, NPN	941.04, 967.07	(80 ÷ x) + 3	7-60%
Sugar, total as invert	925.05	12	24-37%
Minerals			
Calcium	927.02, 968.02	(14 ÷ x) + 6	0.5-25%
		10	10-25%
		12	<10%
Cobalt	968.08	25	0.01-0.16%
Copper	925.56	25	0.03-1%
Fluorine	975.08	40	ppm
Iodine	934.02, 935.14	40	ppm
Iron	968.08	25	0.01-5%
Magnesium	968.08	20	0.01-15%
Manganese	968.08	30	0.01-15%
Phosphorus	964.06, 965.17	(3 ÷ x) + 8	0.5-20%
Potassium	975.03, 925.01	15	0.04-8%
Salt	969.10	(7 ÷ x) + 5	0.5-14%
	943.01	(15 ÷ x) + 9	0.5-14%
Selenium	969.06	25	ppm
Sodium	AA	20	0.2-4%
	ICP	15	0.2-4%
Zinc	968.08	20	0.002-6%
Vitamins			
Vitamin A	974.29	30	1,200-218,000 IU/lb
Vitamin B_{12}	952.20	45	
Niacin	961.14, 944.13	25	3-500 mg/lb
Pantothenic acid	945.74	25	4-190 mg/lb
Riboflavin	970.65, 940.33	30	1-1500 mg/lb

[1]Method reference from AOAC (2016).

[2]Analytical variance and concentration range based on AAFCO historic check sample data from AAFCO (2018). The table denotes a true analytical variation and not a tolerance. The values apply both above and below the guarantee and are equally correct.

[3]x = % guarantee. For example, for a 10% protein guarantee the AV, % = (20 ÷ 10) + 2 = 4%. This means the allowed AV is 4% of 10% or ±0.4.

List 1. Commercial laboratories performing analysis of complete feeds and feed ingredients

Barrow-Agee Laboratories
1555 Three Place
Memphis, TN 38116
(901) 332-1590
www.balabs.com

Colorado Analytical Laboratory
P.O. Box 507
Brighton, CO 80601
(303) 659-2313
www.coloradolab.com

Cumberland Valley Analytical Services, Inc.
4999 Zane A. Miller Drive
Waynesboro, PA 17268
(800) CVASLAB
(301) 790-1980
www.foragelab.com

Eurofins Nutrition Analysis Center
2200 Rittenhouse Street Suite 150
Des Moines, IA 50321
(515) 265-1461
www.eurofins.com

Great Plains Analytical Laboratory, Inc.
9503 N Congress Avenue
Kansas City, MO 64153
(816) 891-7337
www.gpalab.com

Midwest Laboratories, Inc.
13611 B Street
Omaha, NE 68144
(402) 334-7770
www.midwestlabs.com

North Dakota State University
Veterinary Diagnostic Laboratory
(mycotoxins only)
NDSU Dept. 7691
P.O. Box 6050
Fargo, ND 58108
(701) 231-7527
(701) 231-8307
www.vdl.ndsu.edu

NP Analytical Laboratories
Checkerboard Square
St. Louis, MO 63164
(800) 423-6832
(314) 982-1310
www.npal.com

Romer Labs, Inc.
(mycotoxins and residues)
130 Sandy Drive
Newark, DE 19713
(302) 781-6400
(302) 781-6378
www.romerlabs.com

SDK Laboratories, Inc. 1000
Corey Road
Hutchinson, KS 67501
(877) 464-0623
(620) 665-5661
www.sdklabs.com

Servi-Tech, Inc.
1816 East Wyatt Earp
P.O. Box 1397
Dodge City, KS 67801
(620) 227-7509
www.servitech.com

Servi-Tech, Inc.
1602 Park West Drive
P.O. Box 169
Hastings, NE 68902
(402) 463-3522
www.servitech.com

Ward Laboratories Inc.
4007 Cherry Ave.
P.O. Box 788
Kearney, NE 68847
(800) 887-7645
(308) 234-2418
www.wardlab.com

Waypoint Analytical, Inc.
2790 Whitten Road
Memphis, TN 38133
(800) 264-4522
(901) 213-2400
www.waypointanalytical.com

This listing is for information purposes only and does not constitute an endorsement of the labs listed nor a discredit to any lab inadvertently omitted from the list.

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Herrman, T. 2001. Sampling: Procedures for feed. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2036. Available at: http://www.ksre.k-state.edu/bookstore/pubs/mf2036.pdf

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