Director's Digest
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Animal Fat and Protein Ingredients Contribution to Modern Swine Production

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Swine nutritionists traditionally included fat and protein ingredients derived from animal sources for supplying amino acids, energy, minerals and other trace nutrients when formulating swine diets. The advent of the corn-soy concept compromised the use of animal by-products and many other nutrient sources in favor of the simplicity of on-farm blending of local corn, commodity soybean meal, and a package of vitamins and minerals. The economies of least cost formulation were thrust aside to keep simple the selection of ingredients and nutrient standards. As the diet complexity was diminished so was the quality of mixing and equipment to manufacture the feed. With modern swine production and the demands for high performance, emphasis is once again placed on quality, capability of manufacturing facilities that incorporate central milling, increased capacity, effective use of computer formulation, and the ability to utilize vast numbers of ingredients compared to on-farm mixing.

Animal by-product ingredients contribute opportunities for use in all phases of modern swine production. In addition, animal by-products add value to many other ingredients when computer technology is utilized. Today this can be accomplished with equipment as economical as laptop computers. The basic referenced ingredients when encompassing animal by-products include animal fats (tallow, choice white grease, poultry fat, and yellow grease), meat and bone meal, fish meal, blood meal, feather meal, and poultry by-product meal as well as specialized ingredients including plasma protein, spray dried egg, whey, and lactose.

Fat incorporation in swine diets has moved from simplistically inserting arbitrary levels to computer selected fat inclusion to attain fixed levels of metabolizable energy (ME), commensurate with the other ingredients. Fat truly adds value to lower energy ingredients rich in amino acids.

ME (kcal/kg	3410	3586
Grower: (25-55 kg)		
Daily Gain, kg	.74	.75
Daily Feed, kg	2.00	1.78
Gain/Feed	.370	.420 (13.5%)[x]
Finisher : (55 to 100 kg)		
Daily Gain, kg	.94	.92
Daily Feed, kg	3.12	2.81
Gain/Feed	.301	.327 (8.6%)[x]

Washam (1985)

[x]Percentage improvement due to added energy

The advantage to high energy diets is even greater during summer months. Stahly and Cromwell (1989) conducted a growing-finishing study in which he compared zero and five percent added fat in a winter study from November to March and an identical study from May through September. The benefit to the added fat in feed efficiency was 12.6 percent in the summer months and 9.5 percent during the winter (see Table 4). The reduced heat of digestion that occurs with high fat diets was beneficial in the summer. Since most fat is digested by enzymes rather than fermentation, the heat of digestion will be reduced in higher fat diets.

Table 4. Relationship of Season of the Year and Dietary Fat Level on Swine Performance

Season	**Winter**		**Summer**	
Months	**Nov-March**		**May-Sept**	
Da. Max. Temp: °C	**2-13**		**21-33**	
Tallow (%)	**0**	**5**	**0**	**5**
Daily Gain, kg	.78	.79	.79	.86
Gain/Feed	.282	.309 (9.5%)*	.341	.384 (12.6%)*
Backfat, cm	2.8	2.9	2.48	2.47

Stahly and Cromwell 1989

*Percentage improvement due to added fat

Fat slows the rate of passage in the digestive tract and thereby increases the availability of other nutrient sources for digestion. Diets containing an excess of three percent fat can increase protein digestion by as much as five percent.

Energy Studies for Nursery Pigs

The advantages of high energy diets may be even greater for nursery pigs with limited digestive tract capacity. A typical response to increase added metabolizable energy was reported some years ago by McConnell et al. (1982) with pigs weaned at 21 days and has been replicated many times since. They fed diets containing 3,100, 3,300, 3,520, and 3,740 ME kcal/kg. In two separate studies, daily gain increased linearly through 3,520 kcal, while feed efficiency continued to be improved through 3,740 ME kcal/kg (see Table 5).

Table 5. Energy Levels for Weaned Pigs

The benefit to added dietary fat continues on through lactation. Numerous research trials confirm the data by Washam (1986), showing the improved lactation and pig performance when sows are fed high-energy diets. In this large study, sows fed high energy diets in lactation had higher concentration of milk fat, less weight loss during lactation, greater rebreeding conception at first estrus post-weaning, and supported greater gain by the nursing pigs (see Table 8).

Table 8. Effect of Increased Energy in Lactation Diets on Milk Quality and Sow and Pig Performance

	Regular Energy
Milk Fat, % of DM	36.3
Oleic Acid, % fat	24.2
Weaning wt. of litter[a]/, kg	53.3
Sow wt. change[a]/, kg	11.4
Rebreeding conception at 1st estrus, %	73.9

[a]Pigs were weaned at 26 days; 400 sows. *Washam 1986*

In modern high technology swine production with highly disciplined systematic management, it is critical that the weaning to estrus interval be accomplished in four to six days. Johnson, Wilden, and Miller (1987) clearly demonstrated the benefits of high energy diets on maximizing sows returning to estrus in four to five days post-weaning. By adding 3.5 or 10 percent fat to lactation diets they attained 5.2 and 4.5 days average return to estrus (see Table 9).

Table 9. Benefit of Feeding High Fat (energy) Lactation Diet on Reducing Weaning to Estrus Interval

Added Fat, %	0	0	3.5	10.0
ME (kcal/kg)	2612	2654	3243	3578
Sow lactation wt. loss (kg)	37.5	34.9	29.5	20.2
Sow lactation back fat loss (mm)	12.0	9.4	6.8	4.5
Sow body fat at weaning (%)	18.3	21.1	26.0	30.8
Weaning to estrus internal (days)	30.1	12.9	5.2	4.5

Johnson, Wilden, and Miller 1987

In studies conducted at North Carolina State University (Averette and Odle, 2002), sows were fed either zero versus 10 percent dietary fat beginning on day 90 of gestation. Piglets suckling fat supplemented dams grew up to 15 percent faster than control pigs nursing unsupplemented sows. The improved growth was correlated with elevated milk fat and insulin-like growth factor concentrations associated with fat supplementation.

Pork Quality – Influencers

The pork industry is constantly seeking economical methods to increase both production efficiency and pork quality. Three nutritional management "tools" at pork producers' disposal that have been demonstrated to do that are (1) adding rendered animal fats to diets, (2) adding the

Table 10. Lysine and Arginine in Plant and Animal Products

	Animal Source			Plant Sources	
	% Lys	%Arg		% Lys	%Arg
			Rice	.24	.59
Blood Meal	6.9	2.4	Corn	.22	.52
Meat & Bone	2.6	3.3	Milo	.40	.60
Menh Fish Meal	4.7	3.2	Reg SBM	2.9	3.4
Skim Milk	2.6	1.1	Deh SBM	3.2	3.8
Whey	1.1	0.4	Midds	.60	1.0
T. Yeast	3.8	2.6	Cot Sd Meal	1.7	4.6
Spray Dried Egg	3.2	3.0	Sun Fl Meal	1.7	3.5
Poultry By Prod. Meal	3.3	3.9	Wheat Germ	1.4	1.8
Casein	7.0	3.4			

A series of studies conducted by Parsons et al. (1979) showed the beneficial effects of adding blood meal to a corn-soy diet in starter, grower, and finisher diets (see Table 11). In each stage of growth, gain and efficiency were improved by the inclusion of blood meal diets that were formulated to a constant level of lysine, but by adding blood meal the arginine level was significantly reduced.

Studies conducted by DeRouchey et al. (2000) compared the bioavailability of lysine of spray-dried blood meal, blood cells, and crystalline lysine in nursery pigs. Regardless of the lysine source, average daily gain improved linearly as dietary lysine increased. Using L-lysine with the assumed lysine availability of 100 percent, the lysine bioavailability of spray-dried blood meal and blood cells as determined by a slope-ratio were 103 and 102 percent respectively.

Table 11. Influence of Amino Acid Balance on Swine Performance

	Starter		Grower		Finisher	
	C/SBM	C/SBM/BM	C/SBM	C/SBM/BM	C/SBM	C/SBM/BM
Arginine %	1.12	.92	.84	.68	.74	.56
Lysine %	1.01	1.01	.75	.78	.64	.66
A/L Ratio	1.11	.90	1.12	.84	1.15	.85
Daily Gain, kg	.38	.46	.76	.84	1.90	1.94
Gain/Feed	.429	.480	.431	.526	.292	.304

C = Corn; SBM = Soybean Meal; BM = Blood Meal
Parsons, et al., 1979

One of the benefits of substituting synthetic lysine into a corn-soy diet is that by lowering the soybean meal the concentration of arginine is reduced, although still quite excessive. Some companies that utilize multiple ingredients in computer formulating of diets will insert an upper limit on arginine to minimize the excess level as much as practical. One of the benefits of using fish meal and whey in nursery diets is that the arginine level is reduced in relation to the lysine content of the diet. Meat and bone meal and poultry by-product meal, each of which contain

Immune Globulin Value in Animal Products

Most first phase diets for weaned pigs contain either plasma protein or spray-dried egg to provide a dietary source of immune globulins. These immune globulins bathe the upper intestinal tract with immune protection resulting in increased gain, intake, and feed efficiency during the period young pigs are developing immune response capability.

Safety of Animal By-Product Ingredients

Rendering is a process of controlled heating to remove moisture, facilitate fat separation, and produce aseptic material. Depending on the exact process, temperatures of 240 degrees to 285 degrees Fahrenheit (F) at corresponding times provide for the inactivation of bacteria, viruses, protozoa, and parasitic organisms. Animal protein meals have been stigmatized and more closely scrutinized for bacterial contamination, especially for *Salmonella*, than other feed ingredients. *Salmonella* are destroyed by heat when exposed to temperatures of 130 degrees F for one hour or at 140 degrees F for 15 minutes. Thus the opportunistic and ubiquitous nature of *Salmonella* and other pathogenic bacterial may re-contaminate products after cooking or processing, during storage, transport, and handling. Post process contamination is of concern for all feed ingredients and not restricted only to animal proteins. Davies and Funk (1999) completed an extensive review of *Salmonella* epidemiology and control. This report, as well as other databases, suggests that all feed ingredients may be contaminated with *Salmonella* (see Table 13).

Table 13. Incidence of Salmonella In Feed Ingredients.

		Country				
Ingredient	Item	Netherlands [a]	Germany [b]	USA [c]	Canada [d]	United Kingdom [e]
Animal Proteins	Samples	2026	17	101	Not reported	120
	% Positive	6	6	56	20	3
Vegetable Proteins	Samples	1298	196	50	Not reported	2002
	% Positive	3	26	36	18	7
Grains	Samples		37		Not reported	1026
	% Positive		3		5	1
Fish Meal	Samples				Not reported	1316
	% Positive				22	22

[a] *Beumer and Van der Poel, 1997*
[b] *Sreenivas, 1998.*
[c] *McChesney et al., 1995*
[d] *Canadian Food Inspection Agency, 1999*
[e] *Brooks, 1989*

It is now recognized that feeds of plant origin, i.e., soybean meal and corn, are often contaminated with *Salmonella*. The rendering process has been shown to be one of the most efficacious methods for processing the raw inedible by-product materials from animal production. Incineration and alkaline/acidic digestion, though microbiologically effective, result in nutritional denaturation of the material. Rendering, which utilizes a time/temperature control process, preserves the nutrient contents of the derived ingredients.

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