Factsheet

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Nutrient Composition of Feed Ingredients for Swine

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INTRODUCTION

Feed costs represent 65%–75% of the variable costs of swine production. As a result, feed costs play a major role in determining the profitability of a swine enterprise. While corn and soybean meal are the main ingredients for supplying energy and protein to swine in Ontario, there are many suitable less costly alternatives that can meet nutritional requirements. The purpose of this factsheet is to provide an overview of some basic swine ration considerations and provide nutrient values for a variety of ingredients that can be fed to pigs.

Price relationships can vary greatly depending on seasonal variability, and global and local markets. To supply a nutritionally balanced diet at a minimal cost, pork producers and nutritionists must be able to evaluate the cost effectiveness and nutritional value of various feed ingredients. Least-cost computer ration formulation programs are available to design rations that will meet the animal's nutritional requirements for the least cost. Feed manufacturers and large farms can effectively use these programs because they can purchase and maintain large inventories of a number of ingredients. Even producers who do not have the storage or processing facilities for large quantities of ration ingredients should be aware of feeding alternatives and possible ingredient substitutions that may improve profitability.

Energy and protein are the main nutrient components in a swine ration. Grains such as corn, barley, wheat and oats have traditionally supplied energy, while protein has come from meals produced from oilseeds such as soybean. Feed ingredients also supply essential vitamins and minerals to the pig.

Many alternative feeds useful in swine rations are byproducts of the food industry. These are termed recycled food products, and they are regularly used in manufactured feed to provide required nutrients at a reduced cost. Many of the byproducts from these processes are approved as single ingredient feeds in the federal *Feeds Act* and Regulations governed by the Canadian Food Inspection Agency (list of approved feed ingredients) and can readily substitute for a portion of the energy or protein supply in a complete feed. The CFIA has restrictions on recycled feed products related to meat, spent cooking oils, degraded and contaminated products. Any product that contains or has come into contact with meat or meat byproducts is not approved by the CFIA as a feed ingredient unless it has been processed in an approved manner. It is important to note that a farm may have additional constraints on ingredient use if enrolled in certain programs such as Organic or Ractopamine Free programs. Ensure that any ingredient you feed is approved by the CFIA as well as any certification program your farm participates in before feeding.

Alternative feeds can be used to provide a portion of the energy or protein in swine rations. The appropriate amount to use will depend on the cost, nutrient availability (amount x digestibility), quality of protein, amino acid profile, palatability, presence of anti-nutritional factors, storage life and age of the pig for which the feed is intended. The following are some considerations when formulating swine rations.

COST

Cost is one of the most difficult factors to determine when considering the use of alternative feeds. A producer must take into account the amount of nutrients supplied by the replacement feed. This can be extremely difficult since most ingredients cannot be directly compared due to differences in nutrient content and variability in digestibility of those nutrients. A good feed formulation program will account for these factors and allow rations to be formulated to meet the needs of the pig. It is important to note that the ultimate cost of any ration change must also take other factors into consideration such as impact on animal growth and carcass quality, transportation, special processing needs and storage.

ENERGY CONTENT

Approximately 50% or more of the cost of feed can be attributed to providing energy (calories) to the pig, so it is important to not under- or over-supply energy in diets. When formulating rations for pigs, it is common to use the digestible energy (DE) or net energy (NE) systems. The main difference between these two systems is that NE accounts for the amount of heat (or energy) lost by the animal from the digestion/absorption/deposition processes needed to turn the feed into protein and fat. Some ingredients are much harder for the animal to digest (e.g., high-fibre ingredients), whereas others are easier (fats). For hard-to-digest ingredients, the DE system overestimates the amount of energy available, but the NE system corrects for this and provides a more accurate representation of what the animal can actually use for metabolic processes, growth and reproduction. The use of the NE system for formulating diets becomes extremely important when using alternative feed ingredients, to ensure animal needs are met and least-cost diets are produced.

PROTEIN QUALITY

Protein quality refers to the amino acid content of the feed ingredient. Since lysine is the most limiting essential amino acid in corn-soybean meal-based rations, it is important that lysine be considered when valuing replacement feeds. For example, corn gluten and wheat contain a high level of protein relative to the amount of lysine. If a ration was prepared with these ingredients based solely on the protein concentration, the pigs would not be provided with sufficient lysine to support optimum performance. As a result, rations for swine should be balanced according to the level of lysine, instead of crude protein.

NUTRIENT AVAILABILITY (DIGESTIBILITY)

Nutrient availability, or digestibility, is the extent to which a nutrient within an ingredient can be used by a pig. Digestibility of a nutrient is often reported at an apparent level and a standardized level. It is best to use standardized levels when formulating diets, as they are more accurate. Feed ingredients that are high in fibre have lower digestibility values compared to other ingredients. Table 1 shows the basic nutrient content and availability for a wide variety of ingredients that can be included in swine rations.

ANTI-NUTRITIONAL FACTORS

An anti-nutritional factor is any factor in a feed ingredient that interferes with nutrient digestibility. These may include trypsin inhibitors, tannins, lectins or glucosinolates. For example, raw whole soybeans contain a trypsin inhibitor. As a result, they must be heat processed or they will cause a decrease in performance due to decreased protein digestibility and absorption.

Table 1. Nutrient Composition of Ingredients for Swine on a Dry Matter Basis

LEGEND: SID = Standardized Ileal Digestible (percentage of the total that is digestible by the animal)
STTD = Standardized total tract digestibility (percentage of the total that is digestible by the animal)

Feed Ingredient	Dry Matter (DM) (%)	Digestible Energy (DE) (kcal/kg)	Net Energy (NE) (kcal/kg)	Crude Protein (CP) (%)	Total Lysine (%)	SID Lysine (%)	Crude Fibre (CF) (%)	Ether Extract (EE) (%)	Total P (%)	STTD of P (%)
Alfalfa meal	92.3	1,830	897	16.3	0.74	56	25.0	1.7	0.30	55
Bakery meal	90.7	4,300	3,200	12.5	0.42	61	0.8	5.8	0.62	25
Barley	89.9	3,150	2,327	11.3	0.40	75	3.9	2.1	0.35	45
Barley, hulless	89.6	3,266	2,464	12.8	0.51	65	1.1	3.2	0.36	36
Beet pulp, dried	88.9	2,910	1,660	7.9	0.51	50	17.2	0.8	0.10	60
Blood plasma	92.0	4,546	2,506	77.8	6.90	87	0.8	2.0	1.28	98
Brewer's grains, dried	92.0	2,100	1,155	26.5	1.08	80	14.2	4.7	0.58	39
Canola	94.6	5,234	4,059	22.1	1.01	73	6.1	43.6	0.70	32
Canola meal	93.1	3,273	1,890	37.5	2.07	74	10.5	3.2	1.08	32
Corn	88.3	3,451	2,672	8.2	0.25	74	2.0	3.5	0.29	34
Corn, high moisture	67.0	3,890	3,040	6.2	0.28	80	1.8	2.6	0.31	28
Corn distillers, dried grains with solubles (6%–9% oil)	89.3	3,582	2,343	27.4	0.90	61	8.9	8.9	0.60	65
Corn distillers, high protein	91.2	4,040	2,342	45.4	1.22	69	7.3	3.5	0.36	73
Corn distillers, solubles	87.8	3,325	2,312	18.7	0.80	58	4.9	12.1	1.24	N/A
Corn gluten feed	87.1	2,990	2,043	17.4	0.63	66	7.1	4.2	0.78	32
Corn gluten meal	90.0	4,133	2,464	58.3	0.93	81	0.7	4.7	0.49	47
Corn grits, hominy feed	87.5	3,355	2,574	9.1	0.38	71	3.2	7.4	0.73	34
Faba beans	88.1	3,245	2,143	27.2	1.65	85	8.6	1.3	0.42	36
Fat, beef tallow	100.0	7,995	6,895	0.0	0.00	0	0.0	0.0	0.00	0
Fat, choice white grease	100.0	8,290	7,149	0.0	0.00	0	0.0	0.0	0.00	0
Fat, corn oil	100.0	8,754	7,549	0.0	0.00	0	0.0	0.0	0.00	0
Fat, soybean oil	100.0	8,749	7,545	0.0	0.00	0	0.0	0.0	0.00	0
Field peas	88.1	3,504	2,419	22.2	1.63	85	6.2	1.2	0.42	56
Fish meal, combined	93.7	3,958	2,351	63.3	4.56	86	0.2	9.7	2.93	82
Flaxseed	92.0	5,000	3,810	20.7	0.88	75	9.1	34.6	0.63	12
Flaxseed meal	90.2	3,060	1,830	33.3	1.19	77	9.2	6.5	0.87	28
Lentils	88.4	3,860	2,640	23.4	1.62	82	4.3	1.4	0.44	71
Lupins	91.1	3,397	2,043	32.4	1.58	85	14.3	6.1	0.31	57
Meat and bone meal	95.2	3,303	1,961	50.1	2.59	73	2.5	9.2	5.26	70
Meat meal	96.1	3,452	2,010	56.4	3.20	78	2.3	11.1	3.16	86
Milk, dried skim	94.6	3,980	2,695	36.8	2.42	94	0.0	0.9	1.06	98
Milk, dried whey	97.2	3,494	2,704	11.6	0.88	97	0.1	0.8	0.69	92
Milk, dried whole	96.0	5,150	3,900	24.4	1.97	89	0.0	24.0	0.77	90
Oats	87.6	3,050	2,200	11.5	0.45	73	11.5	4.7	0.36	32
Oats, hulless	91.8	4,126	3,164	14.7	0.56	90	2.2	10.7	0.38	N/A
Rye	89.4	3,270	2,460	11.7	0.43	74	2.7	2.0	0.30	50
Soybean meal, 44%	88.8	3,681	2,148	43.9	2.76	88	6.6	1.2	0.64	48
Soybean meal, 48%	90.0	3,619	2,087	47.7	2.96	89	3.9	1.5	0.71	48
Soybeans, roasted	92.4	4,193	2,874	37.6	2.23	81	4.1	20.2	0.53	48
Sucrose	99.0	3,802	2,767	0.0	0.00	0	0.0	0.0	0.00	0
Triticale	88.5	3,320	2,507	13.6	0.46	78	2.5	1.8	0.33	56
Wheat, hard red spring	88.7	3,313	2,472	14.5	0.39	82	2.6	1.8	0.39	56
Wheat, soft red winter	86.4	3,450	2,595	10.9	0.35	82	11.5	1.4	0.30	56
Wheat bran	87.4	2,420	1,646	15.1	0.52	73	7.8	4.7	0.99	56
Wheat middlings	89.1	3,075	2,113	15.8	0.65	78	<7.0	3.2	0.98	56
Wheat shorts	87.9	2,985	2,074	16.8	0.59	76	<9.0	4.6	0.93	56

References for nutrient values: NRC 2012, INRA-CIRAD-AFZ feed tables 2021, Pork Information Gateway.

Table 2. Factors Affecting Inclusion Rate of Feed Ingredients for Swine

Feed Ingredient	Factors Affecting Inclusion Rate
Alfalfa meal	high fibre content; low energy; good source of carotene and B vitamins; low digestibility; unpalatable to baby pigs, better suited for older pigs
Bakery waste, dried	variable in nutrient content depending on the proportion of bread, cakes, dough, tarts or pies; high in energy; similar to corn in protein and lysine content; salt content can be high
Barley	higher fibre and lower digestibility than corn
Beet pulp, dried	high fibre content; low digestibility; acts as a laxative
Brewer's grains, dried	high fibre content; low energy; low lysine; source of B vitamins
Canola meal	higher fibre than soybean meal; less palatable to younger pigs; primary protein source in Western Canada
Corn	high energy; low lysine; high digestibility; palatable
Corn, high moisture	higher moisture content (28% vs 15% for dry); low lysine; diet should be balanced on a dry matter basis
Corn distillers, dried grains with solubles (6%–9% oil)	high fibre; high fat; low lysine; bulky; source of B vitamins
Corn distillers, high protein	high protein with moderate lysine content
Corn distillers, dried solubles	excellent source of B vitamins; better balance of amino acids than other distillers products
Corn gluten feed	low lysine; high fibre; low energy; variable nutrient content; unpalatable; bulky
Corn gluten meal	low lysine; low fibre content; variable nutrient content
Corn hominy	higher fibre and protein than corn; may contain higher energy if fat is not removed
Faba beans	high fibre content; anti-nutritional factors; low vitamin content
Fat	high energy; useful for dust control; will go rancid if not stabilized with an antioxidant
Fish meal	variable nutrient content depending on the source; high in lysine, methionine, calcium and phosphorus; high inclusion can result in fishy flavour in pork
Flaxseed	rich source of omega-3 fatty acids and lignans
Flaxseed meal	reasonably high protein with moderate lysine content; total phosphorus is high but digestibility is low; not readily available in North America
Lupins, sweet white	high fibre content; anti-nutritional factors; low availability of lysine
Meat meal	high in lysine, calcium and phosphorus; variable protein quantity and quality; lower digestibility and availability of protein than to soybean meal
Milk, skim or whole (dried)	high quality protein; very palatable; highly digestible; high lysine content; expensive
Oats	high fibre, low energy
Oats, hulless	low lysine; palatable; variable protein content; expensive
Field peas	low levels of anti-nutritional factors; variable protein content; good amino acid profile; low in methionine
Rye	similar to wheat in nutrient content; susceptible to ergot contamination; anti-nutritional factors; dusty and unpalatable if ground too finely
Soybean meal	with (44%) or without (48%) hulls; good amino acid balance in combination with corn; palatable
Soybeans, roasted	higher energy and lower protein than soybean meal; can cause undesirable after-taste in pork at high inclusion
Sucrose	very palatable; very digestible; increases feed intake
Triticale	high protein and lysine content compared to corn; large variation in nutrient content between varieties; some varieties have anti-nutritional factors and poor palatability
Wheat, hard red spring	lower in energy than corn; similar to corn in digestibility and palatability; higher protein but similar lysine to corn; dusty and unpalatable if ground too finely
Wheat, soft white winter	higher in energy than corn; similar to corn in digestibility, palatability and protein; dusty and unpalatable if ground too finely
Wheat bran	variable protein content; high fibre; low energy; low digestibility; acts as a laxative
Wheat middlings and shorts	compared to corn — higher in protein and lysine; similar in energy; digestible; palatable
Whey, dried or liquid	good quality protein; dry product can be expensive; feeding liquid whey increases manure volume by 2 to 3 times

PALATABILITY

Palatability is the term used to describe the extent to which a pig likes to eat a feed ingredient or ration. As pigs grow older, flavor preferences change, just as they do in humans. Pigs, in fact, have more taste buds than humans (15,000 compared to 9,000) so flavours, or off-flavours, can have an impact on what feed alternatives are feasible. For example, dried whole milk is very palatable in pig rations, while triticale has poor palatability at high inclusion levels.

INCLUSION RATE

Inclusion rate will vary for ingredients depending on palatability, nutrient availability, protein quality, nutrient interrelationship, and the method of processing and feeding. See Table 2. If the ingredient is fed above suggested maximum inclusion rates, animal performance and pork quality may be compromised. Working with a nutritionist to ensure a balanced diet will limit over-feeding of specific ingredients.

NUTRIENT VARIABILITY

Nutrient variability refers to the variation in nutrient content of different samples of a given ingredient. Many alternative feeds such as bakery waste are extremely variable in their nutrient content. This variability makes it more difficult to ensure that the ration is properly balanced. Repeated testing of samples can be useful in assessing nutrient variability in a given feed ingredient. See the OMAFRA factsheet *Nutrient Testing* for more information on sampling and testing procedures.

STABILITY

Stability is the extent to which a nutrient or feed ingredient will remain intact in its original form. For example, vegetable oils that are not stabilized with an antioxidant will go rancid quickly. Rancid oils are very unpalatable and will compromise feed intake.

RESOURCES

Additional information can be found in these documents on the OMAFRA website:

- *Comparative Feed Values for Ruminants*
- *Definitions of Feed Manufacturing and Livestock Nutrition Terms*
- *Nutrient Testing*

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