

# By-Products and Regionally Available Alternative Feedstuffs for Dairy Cattle

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## [Introduction](#) [Types of Feeds](#)

### [High Fiber Sources](#)

[Beet Pulp](#)  
[Brewers Grains](#)  
[Corn Gluten Feed](#)  
[Cottonseed, Whole](#)  
[Distillers Dried Grains](#)  
[Distillers Dried Grain with Solubles](#)  
[Distillers Solubles](#)  
[Distillers Wet Grains](#)  
[Hominy Feed](#)  
[Malt Sprouts](#)  
[Soy Hulls](#)  
[Straws](#)  
[Wheat By-Products](#)

### [Animal and Marine Sources](#)

[Blood Meal](#)  
[Feather Meal, Hydrolyzed](#)  
[Fish Meal](#)  
[Meat and Bone Meal](#)  
[Poultry Meal](#)

### [Medium to High Protein Sources](#)

[Canola Meal](#)  
[Corn Gluten Meal](#)  
[Cottonseed Meal](#)  
[Crambe Meal](#)  
[Linseed Meal](#)  
[Lupin Seeds](#)  
[Safflower Meal](#)  
[Soybeans](#)  
[Soybean Meal](#)  
[Sunflower Seeds, Whole](#)  
[Sunflower Meal](#)  
[Urea](#)

### [Unusual By-Products Sources](#)

[Bakery Waste](#)  
[Beans \(or Peas\), Cull](#)  
[Candy](#)  
[Fat](#)  
[Molasses, Cane](#)  
[Pasta](#)  
[Potato Waste](#)  
[Screenings](#)  
[Starch](#)  
[Wastes, Animal](#)  
[Whey](#)

## [Typical nutrient composition of common by-product \[coproduct\] feedstuffs](#)

[\(DM Basis\) – values will vary between suppliers](#) (12KB PDF table)

## Introduction

Feed costs, the single largest expense in animal production, may be reduced by including locally and regionally grown crops and by-products into animal diets, especially for ruminants. Numerous by-products are produced in our region, but usage is sometimes limited due to poor understanding of their nutritional and economic value, as well as their proper use in dairy cattle rations.

The by-products of food and fiber are commonly referred to as "*coproducts*" because they have significant value as a feed while lowering the cost of feed input. Since ruminants are essentially recyclers, the use of by-products (or coproducts) is particularly suited to dairy cattle that ultimately produce a high-quality product (milk) from the by-products of food, feed, and industrial processing that might otherwise be discarded as waste. So, environmentally as well as economically, by-products will continue to become more important as ingredients in dairy cattle diets.

Although these unusual feeds may be available at reasonable prices, cost is **not** the only factor to consider. Animals sometimes react unfavorably to radical changes in feeds, no matter how good the new feed. Therefore, most uncommon feeds should be used with caution and introduced into the ration gradually, even when low prices favor their use. The nutrition value of the feed, its palatability, possible toxicity or contamination with pesticides or heavy metals, and the effects on digestion and utilization of the total ration are factors that must also be carefully considered.

The potential incorporation of by-product ingredients into ruminant rations requires careful planning, evaluation, and study. Labor costs resulting from the use of unusual feeds can sometimes offset the lower feed prices. Furthermore, many by-products are not consistent in nutrient content due to different milling and processing procedures. In this case, it is important to purchase the feed and formulate rations on the basis of a guaranteed laboratory analysis of each lot of feed.

### List of Abbreviations

ADIN – acid detergent insoluble nitrogen  
ADF – acid detergent fiber  
AF – as fed basis  
CP – crude protein  
DM – dry matter  
EE – ether extract (fat)  
Effectiveness Factor – fraction of NDF as compared to long forage  
(not chopped) which has a value of 1.0  
NEL – net energy of lactation  
NFC – non-fiber carbohydrates (starch source)  
NDF – neutral detergent fiber (from forage)  
TDN – total digestible nutrients  
TMR – total mixed ration  
RUP – rumen undegradable protein  
UIP – undegradable intake protein.

## Types of Feeds

Livestock feeds are typically classified as concentrates and roughages. The concentrate category is further subdivided into energy feeds and protein feeds. However, by-product feeds can have the characteristics of both a concentrate and roughage. Therefore, they are grouped below according to currently accepted classifications. Several by-product feeds are available both fresh (containing high levels of water) and dried. The by-products discussed in this publication are those most commonly available in our region.

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**HIGH FIBER SOURCES** are best suited to extending forage/roughage supplies when good quality corn silage and hay are not readily available at competitive prices. They are usually mixed with the concentrate portion of the diet, due to the nature of handling the product. Many are very palatable, relatively easy to mix into rations, and provide bulk and effective fiber. The incorporation of such by-products has helped solve disposal problems associated with some industries and reduced the quantity of feed grains required in animal production.

### Beet Pulp

*Residue from extracting sugar from sugar beets.*

- Excellent by-product for ruminants, highly palatable due to processing (plant cell rupture).
- Can be fed wet, either fresh or ensiled or after being dehydrated -- available in shreds or pelleted form.
- Pulp mixed with molasses (~3%) before drying increases energy and palatability.
- At least 85% of the energy value of corn, 95% of the energy value of barley.
- Low crude protein -- typically 8% to 10% of DM, but 90% of the protein is pure protein, making it very high quality favoring microbial protein synthesis.
- Contains 17% to 22% crude fiber, but fiber is highly digestible, made up of pectin and sugars that are effective in maintaining milk fat test.
- Effectiveness factor of .43 (fraction of NDF versus 1.0 for long forage).
- High calcium, low phosphorus -- can aggravate Ca:P ratios in alfalfa diets.
- Can be fed up to 50% in dairy concentrate -OR- replace 15% to 25% of the forage DM in diet.
- Dried sugarbeet pulp can be included up to 30% of the dietary DM.

## **Brewers Grains**

*Coproduct from brewing beer, the extracted residue of barley malt alone or in mixture with other cereal grains.*

- 75% of the energy value of corn, 80% of the energy value of barley.
- Medium protein feed ranging from 20% to 25% CP in DM.
- Unique properties provide both digestible fiber and bypass protein (UIP 50% of CP).
- Low in sodium and potassium.

### **Dried**

*Condensed from liquid by-product of brewing beer.*

- Rather bulky and dusty, reduces palatability.
- Should not make up more than 25% of concentrate fed -OR- 5 to 10 lbs of DM per head per day for milking cows.
- Upper limit on forage replacement is 10% to 15% forage DM.

### **Wet**

*Extracted residue from the manufacturing of wort from barley malt and/or other cereal grains or grain products.*

- Nutrient content subject to variation, so purchase based on guaranteed analysis.
- Moisture content can range from 70% to 80%, making it expensive to transport long distances.
- High moisture is limiting factor in formulating silage diets.
- Limit to less than 40 pounds per head per day as fed to milking cows.
- Can supply up to one-half of supplemental protein.
- Do not feed to calves less than four months of age.
- Mineral balance of diet may need to be reevaluated.
- Storage limited to less than seven days in warm weather.

### **Condensed Solubles**

*Condensed liquid coproduct of brewing beer or wort.*

- Dry matter content varies from 20% to 50%.
- Protein content variable; as high as 25%.
- Feed value similar to corn on DM basis.
- Low in fiber and calcium, moderately low in protein, high in energy.
- Feed at 10 to 20 pounds per head per day.
- Not stable. Tends to ferment, expand rapidly.
- Use of propionic acid (3 pounds per ton) helps preserve while maintaining quality.
- Do not feed free choice; very palatable and easily over-consumed.

## **Corn Gluten Feed**

*Shelled corn remains after the extraction of the larger portion of starch, gluten and germ from the wet milling manufacture of corn starch or syrup. It may or may not contain fermented corn extractives and/or germ meal.*

- Wet milling process effectively ruptures cell making the residue very digestible for starch and protein, but it contributes little to ruminal fiber mat.
- Medium protein feed, 20% to 22% CP on DM basis, but protein is low in bypass.
- Protein highly degradable, 70% to 77% of CP (solubility 50% to 55% of CP).
- Low in calcium (similar to corn) and high in phosphorus and potassium.

### **Dried**

*Majority of water removed.*

- More popular form due to advantages in storage, handling, and transportation.
- Medium palatability, cattle adapt quickly.
- Energy level comparable to barley.
- Include up to 50% of grain mixture or 10 to 15 pounds per cow per day. (NDSU research successfully used up to 18 pounds in a 10-week trial.)

### **Wet**

*Remains of wet milling process.*

- Can be included in ration from 25% to 30% of DM intake or 30 pounds per head per day as fed. (1996 NDSU dairy research found optimum use at 19% of total DM intake when protein degradability was not adjusted.)
- Limited shelf life (four to seven days) in summer months. Winter (freezing temperature) prolonged open storage up to 30 days with limited loss due to spoilage.
- Forage effectiveness factor of .56:1.
- Research trials have found milk fat percentage was maintained or sometimes increased with the addition of wet CGF in the diet.

## **Cottonseed, Whole**

*Unprocessed and unadulterated oilseed separated from the cotton fiber.*

- Unique associative effects: high in energy, fat, protein, and fiber yet very palatable to cattle, making it an exceptional dairy supplement that contributes to rumen health.
- Linted cottonseed referred to as "fuzzy"; with lint removed referred to as "delinted."
- Delinted slightly higher in fat and protein than whole cottonseed; however, feeding of acid delinted cottonseed **not** recommended.
- Upper limits are 6 to 7 pounds of DM per cow per day. Inclusion rates are restricted because of their high fat content, especially with other high-fat ingredients in the diet. Total plant fat sources should not exceed 1 to 5 pounds per cow per day.
- Effectiveness factor of 1.3:1. An excellent forage replacer contributing to rumen mat formation as well as ration energy, but difficult to handle due to bulkiness.
- Upper limit on forage replacement is 25% to 35% of forage DM.
- Gossypol toxicity or adverse subclinical effects on reproduction should not be a concern where no more than 15% cottonseed products are included in the total diet.
- Cottonseed should be monitored for aflatoxin contamination.
- Not recommended as a feed for dairy bulls. Gossypol contributes to infertility.

## **Distillers Dried Grains**

*Fermentation coproduct of ethyl alcohol distillation following yeast fermentation of mash.*

- Type of grain may vary, but generally included in the name: e.g. barley, cereals, corn, rye, wheat.
- Crude protein, fat, color, and texture are highly variable.
- Medium protein feed. Crude protein normally varies between 23% and 32%.
- Source of UIP, approximately 55%.
- Same energy value as corn.
- Fat varies between 3% and 11%.
- Very palatable.
- Safe to feed at relatively high levels; 15% to 40% of concentrate mix. Upper feeding limits are listed at 10 to 15

- pounds of DM per cow per day, but daily intake of 5 to 10 pounds of DM per cow per day are more common.
- Be aware of potential heat damage. ADIN used by forage testing laboratories to estimate heat damaged protein from processing.
  - Not recommended for use in high corn silage-corn grain diets.
  - Effectiveness as a forage replacer is 20% to 30% of forage DM in the diet.

## **Distillers Dried Grain with Solubles**

*Product obtained after the removal of ethyl alcohol by distillation from yeast fermentation of a grain mixture by condensing and drying at least three-fourths of the solids of the whole stillage.*

Recommended use similar to distillers dried grains.

Similar in energy and protein to distillers dried grain, and low in lysine.

## **Distillers Solubles**

*Obtained from condensing the thin stillage fraction.*

- Dry matter content ranges from 6% to 26%.
- Crude protein ranges from 30% to 35% of DM.
- Maximum daily intake is about 30 pounds per cow (8 pounds of DM per cow).

## **Distillers Wet Grains**

*The product obtained after removal of ethyl alcohol by distillation.*

- Nutrient analysis similar to distillers dried grains, except moisture content.
- Feeding limits similar to brewers wet grains, 5 to 10 pounds of DM per day.

## **Hominy Feed**

*Product of dry corn milling for table corn meal, producing pearl hominy and corn grits. The useful by-products are: hominy feed, corn bran, corn germ cake, and corn germ meal. Hominy feed is defined as a mixture of corn bran, corn germ, and part of the starchy portion of either yellow or white corn kernels.*

- Fiber, starch, and fat content of hominy feed vary considerably. Laboratory analysis is recommended.
- Slightly more energy and protein than corn.
- Fat content may vary depending on manufacturing process (5% to 12%).
- Very palatable and can be included in ration at high levels, similar to corn.
- Physical form is fairly fine relative to corn that is processed on-farm, enhancing its energy value and content of ruminally fermentable carbohydrate.
- Upper feeding limit is 10 to 15 pounds of DM per cow per day; often restricted because of its high fat content.

## **Malt Sprouts**

*Consists of dried sprouts and rootlets produced from malting (germination or sprouting) of barley for beer. The sprouts are separated from the malt and pelleted.*

- Medium protein, medium to low energy, and high in fiber.
- Should contain at least 24% protein.

- Has about 82% the TDN of corn.
- Product may be dusty and tend to be bitter, reducing palatability.
- Limited forage replacement value. Forage effectiveness factor of .48:1.
- Limit to not more than 20% of rations for high producing cows.
- Upper limit on forage replacement is 15% to 25% of the forage DM in diet.
- Associative effects believed to improve fat test by contributing to rumen fiber mat.

## Soy Hulls

*Consists primarily of the outer covering of the soybean after processing.*

- Slightly more TDN than beet pulp or oats, 88% of the energy value in corn.
- It should contain not less than 13% CP and not more than 32% crude fiber.
- Contains high levels of ADF (50% to 55%) and NDF, but a very digestible fiber.
- Palatable, but tends to be bulky, limiting intake.
- Inclusion rates restricted to 45% of grain mix, but generally limited to 5 to 10 pounds per cow per day because of its high fat content.
- Used in rations to replace carbohydrates from starch sources.
- Use in early lactation diets allows the formulation of high NDF, moderate NFC diets of high energy density.
- Limited forage replacement at 10% of dietary forage DM, effectiveness factor at .25:1.
- Soybean flakes, soyhulls, and soybean hulls are all similar feeds and good sources of highly digestible fiber.
- Sunflower hulls, by contrast, are low in digestibility but add bulk to the diet and absorb liquids such as molasses.

## Straws

*Typically post harvest small grain crop residue.*

- Much lower in feeding value and less palatable than hay from the same plants before fully matured.
- Most useful in rations for animals not being fed for high production, such as dry cows and yearling heifers. Must be properly supplemented.
- Of the cereal straws, oat straw is the most nutritious, followed by barley, wheat, rye, and rice, in order of palatability and digestibility.
- Wheat chaff may contain up to 11% CP, 3% fat, 3.5% fiber, and 39% readily available starch and sugars.
- Sunflower chaff (combine waste and head pieces) is useful for dry cows and heifers.
- Many are better suited for bedding unless supplemented with energy, protein, minerals, and vitamin A.
- Treatment with sodium hydroxide, ammonia, and other substances shows promise of increasing the feeding value.

## Wheat By-Products

### Bran

*Coarse outer covering of wheat kernel separated from cleaned and scoured wheat.*

- Bran is palatable, mildly laxative, and bulky, making it fairly popular in concentrates for dry cows.

### Middlings

*Consists of fine particles of wheat bran, wheat shorts, wheat germ, wheat flour, and some of the offal from the tail of the mill. Approximately 20% of the original wheat kernel may end up in wheat midds.*

- Middlings (or midds) are generally used as a grain replacer.
  - Moderate source of protein (18% to 20%), medium energy and contains no more than 9.5% crude fiber.
  - Often restricted use because of high proportion of ruminally degraded protein (75% of CP).
  - As a forage replacer, effectiveness factor is .57:1. Effective fiber is lower than compared to beet pulp or soyhulls.
  - Upper limit on forage replacement is 20% to 25% of forage DM.
  - Grain rations with more than 20% midds result in decreased milk production.
  - Generally recommended to limit intake of midds to 8 pounds per cow per day or 15% of the total ration.
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**MEDIUM TO HIGH PROTEIN SOURCES** are best suited as a substitute for soybean meal, the crop preferred by most feeders. Protein represents a major expense when balancing rations. Many oil seed crops offer protein-rich feedstuffs that are readily utilized by livestock. They also offer a good source of bypass or escape protein necessary in the diets of high producing dairy cows. However, protein degradability and availability varies considerably due to type of milling process used.

## Canola Meal

*Meal obtained after prepress solvent extraction of oil from whole seed rapeseed (Brassica spp.). Canola is an improved rapeseed low in erucic acid and glucosinolates.*

- According to marketing specifications, it must contain 35% protein, a maximum of 12% crude fiber, and a maximum of 30 micro moles of glucosinolates per gram.
- Canola meal compares favorably and can replace soybean meal in diets.
- Protein is highly degradable and typically 35% CP.
- Recommend combining with less degradable proteins when feeding to high producing dairy cow rations.
- Amino acid content is very similar to that of soybean oil meal. Leucine, isoleucine, and methionine may be first limiting amino acids in dairy diets formulated for undegradable protein.
- Slightly less palatable than other oil seed meals. Cattle adjust intake in one to five days.
- Research demonstrates its value is very satisfactory in protein content and mineral sources for all classes of dairy animals.
- Incorporate into diets at the following levels.
  - Calf starter . . . . . 20%
  - Total diet (dairy) . . . . 10% to 15%
  - Grain mix (dairy) . . . . 25% to 30%

## Corn Gluten Meal

*Dried residue from corn after the removal of the larger part of the starch and germ and the separation of the bran.*

- May or may not contain fermented corn extractives and/or corn germ meal.
- Both 40% (also known as corn germ meal) and 60% CP are available with 60% CGM the more common of the two by-products.
- Slightly more energy than corn and more energy than gluten feed.
- Source of RUP or escape protein (41% to 55% of CP).
- Palatability can be a problem, especially fed as a top dress.
- Upper feeding limits are commonly two to three pounds of DM per cow per day.

## Cottonseed Meal

*Product obtained by finely grinding the cake which remains after removal of most of the oil from cottonseed.*

- Palatability and availability make it a very common protein supplement.
- Has about 90% of the energy of soybean meal or linseed meal.
- Can replace all soybean meal in ration when economics dictate. No feeding limits, except for CP and UIP restrictions.
- Protein degradability is similar to or slightly less than soybeans (57% versus 65%).
- Fiber content is about 19% ADF.
- Contains gossypol, but not at high enough levels to affect cows when no more than 15% included in total diet DM. However, caution is advised when feeding both whole cottonseed and cottonseed meal, which may collectively approach toxic intake levels.
- Aflatoxin contamination can be a problem in some areas.

## **Crambe Meal**

*Obtained by finely grinding the flakes which remain after removal of most of the oil or remaining cake.*

- Expeller pressed with about 5% residual oil.
- Protein degradability estimated at 30% of crude protein.
- Fiber content about 42% ADF.
- At present, cleared only for beef backgrounding, finishing cattle, and non-lactating dairy.

## **Linseed Meal**

*Obtained after grinding the flakes, cake, or chips which remain after removal of oil from flaxseed by mechanical or solvent extraction.*

- Palatable, mildly laxative, and must not contain more than 10% crude fiber.
- Contains somewhat less energy than soybean meal and is higher in fiber (ADF).
- High in protein with degradability similar to soybean meal.
- No feeding limits, except restrictions imposed by CP and UIP diet specifications.
- Generally included up to 25% of the grain mix or about 9 pounds per cow per day.
- Good source of selenium.
- Supplementation with linseed meal typically produces more bloom and makes for a soft hair coat.

## **Lupin Seeds**

*Oilseed from an annual cool season legume that is common to Canada and the northern tier of counties in the US.*

- Level of alkaloids determine bitterness of beans; above .5% are regarded as bitter.
- Sweet lupins (less than .03% alkaloids) preferred for feeding purposes.
- Protein low in amino acids methionine and cystine.
- Highly degradable source of protein -- 80% of CP.
- Do not use as the only protein source. Best when fed with soybean meal; e.g. 50% lupins and 50% soybean meal.
- Feed at rate of up to 4 pounds per head per day.
- Should be rolled or ground before feeding.

## **Safflower Meal**

*Remains obtained after extraction of oil from either whole or dehulled seed. The oil is prized because of its high level of unsaturates.*

- Meal from unhulled seed has only 20% protein and is high in fiber (ADF).
- Meal made from well-hulled seeds has about 40% protein and much higher energy content.
- Safflower from either source is not as palatable to cattle as more commonly used supplements.
- Usually restricted to 20% or less of the concentrate mix.

## **Soybeans**

*Grown as an oil-bearing seed, its protein value has become equally important as the most widely used protein concentrate in the feed industry.*

- Full fat soybeans (raw not processed) are high in protein and fat (18%).



- Ruminal degradability of protein is highly variable.
- Contain 18% to 20% fat, often restricting their use in diets with other high-fat ingredients, with fat from plant sources not to exceed 1.5 pounds per cow per day.

### **Raw**

*Whole or ground without cooking or removing of the oil.*

- Raw soybeans are generally limited to less than 4 to 5 pounds of DM per cow per day due to high ruminal protein degradability and effects of trypsin inhibitors on protein digestion in small intestine.
- May be included in grain mixes up to 20%.
- Recommend grinding or rolling before feeding. Generally not stored ground or rolled for more than one week because of tendency to become rancid.

### **Heat Treated**

*Heat processed whole soybeans without removing any component parts.*

- Roasting and extrusion are the two common methods of heat treatment. This process allows for a 1 to 2 pound per head per day higher feeding rate of soybeans.
- Properly heat-treated beans are an excellent source of undegradable intake protein.
- Do not feed with urea source unless beans are heat treated. Heating destroys urease enzyme.
- Ruminally undegraded protein in heat-processed soybeans has a high lysine content.
- General recommendation for heat treating: heat to 295°F and steep for 30 minutes. Proper heating eliminates anti-nutritional factors.
- Extruded soybeans fed more than 3 to 4 pounds of DM per cow per day may lead to milk fat depression.

### **Soybean Meal**

*Ground flakes after the removal of most of the oil from either whole or dehulled soybeans.*

- Most commonly used protein source for supplementation due to its high palatability.
- Protein from "expeller" process is less degradable than "solvent" processed soybeans.
- Depending on process (expeller or solvent), meal may be 44% or 48%, respectively.
- Product from whole soybeans must contain not more than 7% crude fiber and not more than 12% moisture.
- Product from dehulled soybeans must contain not more than 3.5% crude fiber and not more than 12% moisture.
- Mechanically-extracted soybean meal must contain not more than 7% crude fiber and not more than 12% moisture.
- Mechanically-extracted (expeller) meals contain more fat than solvent-extracted meals.
- Expeller meals are higher in ruminally degraded protein.
- Generally, no feeding restrictions except for limits imposed through diet formulation for CP and UIP.
- Methionine is its most limiting amino acid for milk protein synthesis.

### **Sunflower Seeds, Whole**

*Annual row crop for oil or confectionery use.*

- Two types: oil seed (38% to 50% fat and 20% protein) and confectionery (about 20% fat and lower in test weight).
- Quite palatable and an excellent energy source.
- Can be included up to 15% of grain mix.
- Feed at a rate equal to 1 pound of fat intake.
- Modest fiber source, because the hulls are quite lignified and short limiting the effectiveness of the fiber.

### **Sunflower Meal**

*Remaining residue after mechanical or solvent extraction of most of the oil from either whole or dehulled sunflower seed.*

- Fiber may vary depending on amount of hull in the meal.
- Increased hulls reduces protein and energy and increases fiber.

- Dehulled contains more fiber and less energy than whole soybeans.
- Protein content will vary with extraction process, ranging from 25% to 49%.
- Most common commercial sunflower meal is a partially dehulled by-product at 34% CP, but 28% and 40% CP products are also available.
- Sunflower meal is less palatable than soybean meal, but not a concern when using.
- General guidelines suggest no more than 20% to 25% (34% CP) in the grain mix.
- Amino acid profile is slightly less desirable than SBM; lysine is the most limiting amino acid.
- Very suitable mineral content, particularly in calcium and phosphorous, when compared to most other meals.
- May be used as major protein supplement with no feeding limits, except those imposed by diet specifications. No problems with goitrogenic substances or nutritional toxins.

## Urea

*Predominantly urea, but may contain other non-toxic nitrogenous compounds from the commercial synthesis of urea.*

- Feedstuffs containing nitrogen in a form other than protein or polypeptides.
- Urea dominates the market, but other forms of NPN (non-protein nitrogen) include ammonium salts (such as biuret) and ammoniated by-products.
- Add 10 lb per ton of wet corn silage or 1% incorporation into the grain mix.
- Maximum of .4 lb of urea per cow per day.
- Very degradable in the rumen.

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**ANIMAL AND MARINE SOURCES** are concentrated sources of protein, ranging from 54% to 90% CP (on a dry matter basis). They are also higher in ruminally undegraded protein fraction ranging from 50% to 80% of CP content. The CP is highly variable, as is its amino acid profile. Because the relative biological availability of calcium and phosphorus are good, supplemental inorganic mineral needs are reduced when these ingredients are fed.

One of the major concerns about using animal and marine protein by-products is related to variation in source of raw materials and/or processing conditions. Another concern is the variability in content of digestible protein (e.g. feather meal). Purchase ingredients from reputable suppliers or dealers willing to assure minimum quality standards. Many of these products require proper storage and handling to avoid salmonella contamination (e.g. meat and bone meal). They should be covered to prevent contact with dogs, cats, rodents, and birds, as well as to reduce spoilage.

## Blood Meal

*Produced from clean, fresh animal blood, exclusive of all extraneous material, such as hair, stomach belchings, and urine.*

Types include conventional cooker dried, flash dried, and spray dried. Spray drying produces a product that retains moisture and is not suitable for feed use. Cooker drying is an old process that results in lack of uniform product. Flash drying (newer, preferred process) produces a product uniform in color with high lysine (9% of CP).

- Very high protein -- 80% to 85% CP, but also rather expensive.
- Good source of undegradable protein (80% of CP).
- Excellent source of amino acids lysine and methionine.
- Not highly palatable, best fed in a total mixed ration.
- Limit to .5 to 1 pounds per head per day.
- Supplementation best suited for dairy animals at high production levels.

## Feather Meal, Hydrolyzed

*Product resulting from pressure treated, clean, undecomposed feathers from poultry slaughter.*

- Hydrolyzation process effects protein availability.

- Not less than 75% of CP must be digestible as measured by pepsin digestibility method.
- Regarded as a source of undegradable intake protein (69% of CP).
- High in protein, moderate in energy.
- Not palatable, requiring gradual introduction into ration.
- May be fed up to 1 to 1.5 pounds per cow per day.

## **Fish Meal**

*Clean, dried ground tissue of undecomposed whole fish or fish cuttings, either with or without extraction of part of the oil.*

- Two types: fish caught for making meal and fish residue remaining after processing for human food or industrial purposes.
- Crude protein ranges 35% to 70% depending on type of product (whole fish or cuttings).
- Several meal-types available, e.g. menhaden, anchovy, herring, white fish.
- Excellent source of undegradable protein.
- Good amino acid balance (high quality) and a good source of B-vitamins.
- Contains high levels of the limiting amino acids tryptophan, lysine, and methionine.
- Introduce into ration gradually.
- Not highly palatable, best fed in a total mixed ration.
- Limit feeding to 1 to 1.5 pounds per cow per day.
- Fits best in diets of high producing cows.

## **Meat and Bone Meal**

*Rendered product from mammalian tissues, including bone, exclusive of blood, hair, hoof, horn, hide trimmings, manure, stomach and rumen contents.*

- Source of undegradable protein (50% CP) and high in crude protein.
- Shall not contain more than 14% pepsin indigestible residue. Not more than 11% of the CP in the product shall be pepsin indigestible.
- Good source of amino acid lysine.
- High in calcium and phosphorus. Contains a minimum of 4% phosphorus. Calcium level shall not be more than 2.2 times the actual phosphorus level.
- Include in grain mix up to 5% diet DM or 1 to 2 pounds per cow per day.
- Not palatable, best fed in TMR and introduced gradually.
- BSE (bovine spongiform encephalopathy) guidelines prohibit feeding ruminant meat or meat and bone to other ruminants. For dairy and beef cattle, use certified pork meat and bone meal.

## **Poultry Meal**

*Consists of ground, rendered, clean parts of carcasses of slaughtered poultry, such as necks, feet, undeveloped eggs, and intestines, excludes some of the feathers.*

- Label includes guarantees for minimal crude protein and crude fat, maximum crude fiber and minimum phosphorus. Calcium shall not exceed 2.2 times actual level.
- Relatively poor balance of lysine and methionine, but a good source of sulfur-containing amino acids because of high cystine content.
- May be fed up to 1 to 1.5 pounds per cow per day.
- Lower restrictions are often imposed because of problems with palatability.
- Best delivered in a TMR versus top dressing.

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**UNUSUAL BY-PRODUCT SOURCES** are regarded as the most non-traditional sources of energy and protein that used in ruminant diets. Limited information is currently available and they vary immensely in nutrient

**composition. Frequent nutrient analysis is advised.**

## **Bakery Waste**

*Pastry products from stores or bakeries. May be received without drying or removal of the wrappers.*

- Consists of various combinations of bread, crackers, cookies, cakes, and doughnuts. Usually dried and ground together.
- Higher in energy than corn, but very low in fiber.
- Restrict to not more than 20% to 25% of grain ration, 10% of the TMR, or 8 pounds per head per day.
- Tends to depress milk fat content when fed at high levels. Avoid more than 1 pound of added fat per cow per day.
- Higher levels may be fed to replacement heifers and dry cows.
- Salt content variable, generally 1% to 3%.
- Highly palatable and may be run through a forage chopper to facilitate feeding.

## **Beans (or Peas), Cull**

*Seed not acceptable for food use.*

- Cull beans and peas contain about 25% CP (DM basis).
- Palatability and protein quality restrict use.
- May comprise 15% to 20% of concentrate DM or 7% to 10% of total mixed ration dry matter. Researchers have fed 25% of grain as field peas with no negative effect.
- Generally recommend rolling prior to feeding.
- Anti-nutritional component of raw navy beans (lectin) reduces nutrient uptake by the small intestine, limiting feeding rate to less than 2 pounds per cow per day.
- Heat processing will minimize detrimental effects of lectins and increase UIP value.

## **Candy**

*Rejected product from candy and sweetener manufacture.*

- Examples include chocolate candy bars, cull gummy bears, lemon drops, and licorice.
- Products available through distributors and sometimes the factory.
- Analysis will vary depending on source.
- Sources of certain nutrients, namely, fat and sugar, but low in protein.
- Highly palatable.
- Limit to 5 pounds per day, equivalent to 1 pound of supplemental fat.
- May be blended with pasta or peanut skins.
- Typical analysis of candy products is: 5.2% CP, 5% ADF, 1.10 Mcal NE<sub>L</sub> per pound, .07% calcium, .17% phosphorus, and 22.4% other extract (fat).

## **Fat**

*Common sources include whole oilseeds, animal fat, and various ruminal-inert granular fat products.*

- Best used in a combination of both plant and animal fat when added to diet.
- Source of concentrated energy -- 2.25 times the energy of carbohydrates.
- Unsaturated fats (vegetable oils) tend to lower milk fat test.
- Saturated fats from animal sources or animal-vegetable blends.
- Increase calcium and magnesium levels in diet to 1% and .3%, respectively.
- Several "dry fat" forms available commercially referred to as inert fats.
- Generally, oilseeds are limited to 1.5 pounds per cow per day or 3% of the total mixed ration dry matter. This limits intake of whole oilseeds to less than 7 pounds of dry matter per cow per day or 15% of the TMR dry matter.

- Can feed animal fat (tallow) at 2% of ration DM (about 1 pound per cow per day) to high producing cows along with whole oilseeds.
- Choice white grease guidelines similar to tallow.
- Restaurant grease is **not** recommended to be fed to lactating cows because of milk fat depression related to trans-fatty acids in vegetable oil.
- Because the fatty acid profile of vegetable oil is more highly unsaturated than animal fat, its feeding rate should be limited to .5 pounds per cow per day and should **not** be fed along with whole oilseeds.
- Total supplemental fat should be limited to less than 5% of ration DM (3% whole oilseeds, and 2% from animal fat) or less than 2.5 pounds per cow per day. This limits total ration fat levels (including basal ingredients) to about 7% to 8% of ration DM.
- Animal fat must be melted and can be difficult to blend in TMR or to feed individually.
- Blending animal fat with the protein concentrate or grain mix at the feed mill or purchasing commercial high-fat supplements make it easier to handle.
- Fat can be fed during lactation as long as the level of milk production (>70 pounds per day) and body condition (BCS <3.0) warrant its use.

## Molasses, Cane

*Coproduct from manufacture of sugar from sugar cane.*

- Highly palatable.
- Used for flavor and control of dust in rations.

## Pasta

*Available from processors and ingredient distributors as straight pasta or blends with other ingredients.*

- Use in limited amounts to avoid milk fat depression because of high starch content. Less restrictive than cooked starch or bread.
- Can be fed at rates from 4 to 8 pounds of DM per cow per day, depending on its starch content.
- Typical analysis, on a dry matter basis: 14.6% CP, 3% ADF, .90 Mcal NE<sub>L</sub> per pound, .02% calcium, .16% phosphorus, and 1.6% fat (EE).

## Potato Waste

*Potato processing waste. Usually a mixture of various components: steam peel, raw chip, french fries, and cooked potato.*

- Potato waste straight from a processing plant may contain varying amounts of inedible or rotten potatoes, french fries, chips, skins, and fats or oils from frying operations. Pay attention to its composition.
- By-product is quite liquid (approximately 75% to 80% moisture), making it difficult to transport and store.
- Primarily an energy source that is highly digestible and very palatable. Caution is required to avoid ruminal acidosis. Cattle will need to adapt to it gradually.
- Protein content (about 9%) is typically only 60% digestible, depending on amount of heat used while processing.
- Low fiber content may be associated with a decrease in milk fat percentage.
- Potato-based rations often vary in calcium and, to some degree, magnesium. A mixture of limestone, dicalcium phosphate, and trace mineral salt is suggested to prevent deficiencies.
- Deficient in fat soluble vitamins requiring added supplementation.
- When feeding culls, use fresh. Can be fed to cows either whole or chopped.
- Do not use frozen, rotten, or sprouted potatoes. Frozen potatoes may cause choking.
- Limit dairy cattle to 25 to 35 pounds per cow per day, on an as fed basis, or 5 to 8 pounds of DM per cow per day.
- Typical nutrient analysis (DM basis) for cull potatoes and potato waste is: 10% CP, 3% ADF, .83 NE<sub>L</sub> per pound, .02% calcium, .24% phosphorus, and .4% EE; and 8% CP, 6% ADF, .87 NE<sub>L</sub> per pound, .16% calcium, .25% phosphorus, and 5% EE, respectively.
- Potato processing wastes can be mixed with chaff, chopped hay, or haylage and preserved as silage, as well as dried and preserved as potato meal.

## Screenings

*Clean out from various small grains and corn.*

- Best grade consists primarily of broken and shrunken kernels of grain, wild oats, and other weed seeds.
- When ground, good screenings approach grain in feeding value and have been used as 25% of concentrate mixes for dairy and 15% to 20% in feedlot rations.
- Light, chaffy screenings are much higher in fiber and resemble straw (more than grain) in feeding value. Restrict to 10% or less of concentrate mixes.
- If screenings contain much mustard, lambs-quarters, and pigweed, their feeding value is very low and may be unpalatable.
- Some weed seeds may cause objectionable flavor in the milk and meat of animals consuming large quantities.
- Some weed seeds pass through the digestive tract and contaminate fields and pastures where manure is deposited.
- Mycotoxins tend to associate with the fines when mold problems exist in the field.
- Vomitoxin is an indicator of mycotoxin contamination.

## Starch

*Unheated starch is available from some candy manufacturers.*

- Most effective when used in rations needing more rumen fermentable starch.
- May comprise up to 15% to 20% of concentrate DM or 7% to 10% of total mixed ration DM, depending on starch content.
- Typical nutrient analysis: 10.8% CP, 4.4 ADF, .85 Mcal NE<sub>L</sub> per pound, .13% calcium, .18% phosphorus, and .4% EE.

## Wastes, Animal

- Recycled animal wastes from broilers or layer-house litter.
- Feeding level in grower and finishing rations for beef cattle and sheep is 5% to 15%.
- Animal wastes are **not** approved as a feed for lactating dairy cattle.
- Mineral levels extremely variable.

## Whey

*Liquid residue of milk separated from curd during cheese making. Consists mainly of lactose, protein, minerals, and waste.*

- Sweet whey (from cheddar and mozzarella processing) has pH of 6.0. Acid whey (from processing cottage cheese) has pH of 4.6 making it less palatable. Acid levels of both whey products drops pH to about 3.5 in two days.
- Corrosive -- store in suitable holding tank (plastic, stainless steel, glass, or wood).
- Should be delivered fresh daily.
- Whey over 36 hours old and of low pH is not as palatable as fresh product.
- Cows adapt slowly to product. May require up to 4 weeks.
- Once accustomed, cows will consume about two-thirds of their normal water intake as whey. Contains about 4% to 7% dry matter, with the solids fraction relatively high in feeding value.
- On DM basis, whey is similar to corn in TDN; contains one-third more protein.
- Most whey contains 11% to 13% CP, energy similar to ear corn. Some whey contains 7% to 8% fat, but more typically .2% to .1% fat (DM basis).
- Few problems are generally encountered. However, bloat and acidosis can occur if supply is allowed to run out and hungry animals over-consume whey in a short period of time.
- Whey is best provided using a tank or watering device, however, flies can be a problem.
- Feeding whey increases urine output.
- It is important that animals fed whey have free access to water at all times. Animals will naturally reduce water

consumption on their own, but it may be necessary to restrict water intake for five to 10 hours each day for several days to encourage intake.

- Intake of liquid whey should be limited to not more than 100 to 150 pounds per cow per day.
- Can also be used in feeding programs for replacement heifers.
- Dried whey products are considered energy feeds and contain 37% to 72% lactose, which is readily fermented in the rumen. It can be added to diets to increase ruminal fermentation and microbial protein synthesis.
- Dried whey is usually more expensive than traditional feed ingredients, limiting its use.

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