

Legumes for dairy cattle

Legume grains may be available at prices that make them seem attractive for cattle feed. These include mungbean, faba bean, soybean, navy bean, peanuts and a variety of peas (field, chick, cow, pigeon, maple pea) - usually split, undersized or weather-damaged seed. Are they suitable for use in dairy rations?

Anti-nutritional factors and utilisation by ruminants

Many raw legume (especially tropical varieties) and other high-protein grains contain anti-nutritional factors; toxic compounds such as proteinase inhibitors, alkaloids and tannins, which reduce intake or the animal's ability to digest feed, reducing growth and production. Alkaloids and lectins (haemagglutinins) can cause scouring or death at high levels. These anti-nutritional factors have major effects on monogastrics, but have less effect on ruminants as microbial fermentation in the rumen can break down some toxic compounds such as the proteinase inhibitors. The cow's protein requirements are supplied mainly as microbial rather than feed protein. Weather-damaged grain may contain fungal moulds and mycotoxins. Low levels of fungal moulds can be tolerated by cattle, with reduced nutritive value the main effect for ruminants, but higher amounts of aflatoxin (common in peanuts) can be fatal.

If they can be detoxified either by the animal or by processing, legume grains and oil seeds are highly digestible, with an energy content similar to cereal grain and protein contents of 20-28% CP. Whole cottonseed contains gossypol, but at moderate feeding levels this is detoxified by an effectively functioning rumen. Hence 2 to 3 kg/day can be fed to lactating cows, with proportionally lower levels for growing animals. It would be unwise, however, to use it for young calves or weaners. Some have high oil contents (soybean, cottonseed) and intake must be controlled to keep lipid content (fats and oils) of the diet below 5%, as fat coats the feed in the rumen, reducing microbial access to break down fibre. Depending on composition of the diet, up to 2 kg of oilseeds can usually be fed. Lupens (round) are widely used in southern states at up to 5 kg/head a day in dairy concentrates, but flat-Albus varieties contain alkaloids and are not suitable for feeding.

Legume grains have been examined much more closely for use for monogastrics - pigs, poultry and humans. If a legume grain is suitable for pigs, it can be assumed to be safe for ruminants. These have been tested at levels of 20-30% of the pig's diet. For lactating cows, a feeding level of 2 kg/day is less than 15% of the diet. Degradation in the rumen provides greater tolerance to low levels of some toxins such as trypsin inhibitors, allowing soybean and peanuts to be fed raw, but unless known, it could be wise to accept similar recommendations to those used for pigs.

Anti-nutritional factors in legume grains may not be completely denatured by rumen microbial action (e.g. alkaloids, lectins). Cooking may still increase responses by cattle. For instance, whole soybeans are widely used in dairy rations in the US and contain trypsin-inhibiting compounds. It is heated (dry cooking) to detoxify it for pigs and improve its utilisation for cattle. Trypsin is a pancreatic enzyme (proteinase) necessary for protein digestion. In monogastrics, feeding soybeans raw results in an enlarged pancreas, poor feed digestion and lowered production.

Anti-nutritional factors and toxins in legume grains

- Trypsin inhibitors: inhibit pancreatic enzyme function, hinder protein digestion and absorption. Rumen degradation reduces toxicity.
- Haemagglutinins including lectins: potent toxins cause slow growth, nausea, diarrhoea, clot red blood cells, death. Lectins are not degraded in the rumen.
- Saponins: cause persistent bloat, when absorbed dissolve red blood cells.
- Tannins: especially found in red or black seed coats. Reduce protein and energy utilisation. Rumen degradation reduces toxicity.
- Alkaloids: large complex group of chemicals, effects range from reduced palatability to causing death.
- Mycotoxins: toxins produced by fungal invasion of weather-damaged grain. High levels of aflatoxins can be fatal. These are more likely to develop on wet feed.

- Gums: in guar, used for glue manufacture, reduce intake and digestibility of feed, can cause scouring. Raw seed is unsuitable as feed for monogastrics or ruminants.

Processing

Processing can be used to destroy some anti-nutrient factors or toxins but is not practical for the individual farmer. Fortunately, rumen digestion reduces problems for cattle. Effective treatment to detoxify legume seeds depends on heat and moisture. Dry heat (roasting) is suitable for seeds such as soybean with high oil content, which aids heat transfer through the grain. With other legumes, adding 10% water or vegetable oil helps transfer heat through the crushed seed to destroy heat-sensitive toxins. Heat-resistant toxins such as tannins and gums, can't be effectively processed. Tannins, however, are of less concern for ruminants, though they can reduce palatability and intake. Moderate tannin levels may lessen bloat risk of high-protein legume pastures. Equipment required for processing is capital intensive and better suited to feed millers. Heating is not a satisfactory method for detoxifying fungal mycotoxins of weather-damaged or poorly stored grain.

Extracted meals derived from legumes and oilseeds are generally useful cattle feeds. Extracted guar meal has been used overseas for cattle. Suitability depends on efficacy of gum removal. Guar is bitter and its palatability low. Autoclaving and enzyme treatment help break down indigestible gums.

Legume grains

- Peas: generally contain nil or only low levels of anti-nutritional factors and can be fed raw, but beans contain varying levels of toxic compounds which require heating to detoxify (Table 1).
- Mungbeans: can be fed in balanced diets without a problem.
- Faba beans: de-hulling or steam heating is beneficial for pigs, but up to 2 kg/day raw seed should be acceptable for cattle.
- Soybeans: roasting might improve responses if used routinely. 1 to 2 kg/day can be fed raw, but oil content and possible longer term effects on the pancreas and the animals' ability to digest feed may make raw soybeans unsuitable for routine use at higher levels.
- Peanuts: contain trypsin inhibitors and high oil content (twice that of soybean). Can be fed raw at 1 to 1.5 kg/day. Ensure Aflatoxin-free and restrict oil intake.
- Dry beans: navy, broad beans contain lectins which suppress appetite, cause scouring and poor growth in pigs. They require moist heat (autoclaving, boiling or extrusion) to detoxify. Low levels of raw seed for short periods may not cause symptoms of toxicity in cattle, but reduced feed conversion is possible. Steers fed navy beans produced antibodies to lectins, indicating adverse effects. Not recommended.

Rumen digestion can reduce negative effects for cattle by denaturing toxic compounds.

Table 1. Anti-nutritional factors in untreated whole-legume grains and their suitability for pig diets

Legume grain	Fat %	Major toxins	Effective heat treatment	Can be fed raw (pigs)	Harmful effects if fed untreated (pigs)
Peas - Chick, cow, field maple, pigeon	1-5	Tannin, trypsin inhibitors* (low levels)	Heat treatment of pigeon pea beneficial for pigs	yes	nil
Lentils	1	none		yes	nil
Mungbean	3.5	Tannins, trypsin inhibitors (low levels)		yes	nil
Faba bean	1.4	Tannin, trypsin inhibitors (moderate levels)	De-hulling, heat treatment beneficial (pigs). Can be fed raw for cattle	Moderate levels	nil at low levels
Soybean	19	Trypsin inhibitors	Autoclave Boiling Extrusion Roasting	no	Poor growth, decrease protein uptake
Broad bean	1-2	Lectin	Autoclave Boiling Extrusion	no	Appetite suppression, scouring, poor growth
Navy bean	2	Lectin	Autoclave Boiling Extrusion	no	
Other dry beans	1-2	Lectin	Autoclave Boiling Extrusion	no	
Lab lab	1	Lectin	Autoclave Boiling Extrusion Roasting	no	
Guar		Gums, trypsin inhibitors	no	no	Appetite suppression, scouring, poor growth
Lupin - round	6			yes	Nil
Lupin - flat (Albus varieties)	9	Alkaloids	no	no	Liver damage, poor growth, vomiting
Peanut	45	Trypsin inhibitors, aflatoxin risk	Autoclave Boiling Extrusion Roasting	no	Scouring, poor growth
Pecan nut					Aflatoxins - death
Cottonseed	20	Gossypol (Low levels can be denatured in rumen)	no	no	Scouring, poor growth

Feeding level

Moderate quantities (up to 1 kg/cow/day) of most legume grains and higher level (2 to 3 kg/cow/day) of low-toxicity grains are not likely to cause problems over short periods. Effects of those with higher content of anti-nutritional factors on efficiency of feed utilisation at high levels or for long periods are less certain. Supplements will be most effectively utilised when fed as balanced rations. Dietary oil levels must be kept below 5% to avoid reducing digestibility of forage in the rumen. Feed quality also must be considered. Low-priced grain with high levels of hulls and under-developed seed is lower in nutritive value, so may not be cheap feed.

Acknowledgments

The primary information for this article was provided by colleagues Danny Singh, John Kopinski and Albert Takken.

Source: Queensland Department of Agriculture, Fisheries and Forestry; 2009