CHAPTER 8
The feed value of unusual feedstuffs

This chapter reviews some of the less-common feed supplements that may be used when the usual grain and hay sources are in short supply. They are rarely a balanced feed in themselves, so a summary of their particular nutritional value is provided, along with the suggested inclusion levels in feedlot and total mixed ration diets. Warnings of some of the recognised issues associated with the use of some of these feeds are also provided.

Key messages

- **A wide range of unusual feedstuffs can be effectively fed to livestock.**
- **They rarely meet all the nutritional needs of stock, so should be included in rations at low to moderate levels.**
- **Some products may have issues with toxicity or chemical contamination. Request a Commodity Vendor Declaration and consider a feed analysis for minerals and other residues.**
- **Consider storage and handling requirements as well as shelf life before purchasing alternative feedstuffs.**
- **Feed testing of all feedstuffs is recommended to assist with ration formulation.**

Although unusual feedstuffs are commonly available in fairly regular supply, inquiries about their value for feeding to livestock increase when feed for grazing livestock is short, such as during droughts.

Apart from these feedstuffs generally being of poor nutritional value, they can also contain chemical residues that can contaminate meat and milk products when used as livestock feed.

All supplementary feeds may contain chemical residues. However, unusual feedstuffs pose a much greater risk because residue transfer assessments are unlikely. The same applies to imported feedstuffs that may have high feed value to stock but have an unknown history of chemical usage.

Agricultural chemicals used on fruit and vegetable crops are typically designed to be eliminated from the edible parts of the plant at harvesting. Some residues may still be present – and in some cases concentrated – in the waste plant material after processing. When this waste plant material is fed to stock, problems can occur. These chemicals are not designed to be ingested by livestock. Unless animal residue studies have been conducted, little is known about the effect of these chemicals on stock and about the persistence of residues of these chemicals in animal tissue and in the food chain.

There is a very real possibility that the meat and animal products from stock fed unusual feedstuffs containing chemical contaminants will themselves become contaminated with these chemicals. This can have a severe impact on trade and market access as well as animal and human health.

Do not feed unusual feedstuffs to stock without first establishing that the material is suitable. Producers should ask the supplier of unusual feedstuffs to certify that the material they are supplying is suitable for the purpose for which it will be used.

A by-product Commodity Vendor Declaration, which will show the full chemical history of the potential feed, should be requested. A Commodity Vendor Declaration form is available for download on the MLA website. Check the website for the most up-to-date version.

Ideally, unusual feedstuffs should be tested for chemical contamination by an accredited testing laboratory before being used as drought feed, although this in itself may not provide a satisfactory guarantee of suitability as analytical tests typically only screen for a narrow range of chemicals. A number of feed analysis laboratories will test for nutritional values (like energy and protein) as outlined in Chapter 3 – What to feed sheep. Further analyses of mineral, heavy metals, pesticide residues and other issues relating to food and animal safety are available from some laboratories.

The composition of many feedstuffs varies widely because of differences in climate, soil conditions, maturity, variety, management and processing factors. The chemical content of unusual feedstuffs may also vary from batch to batch. The data in this chapter should be considered as a guide rather than a precise statement of nutrient composition.

Some feeds can be unbalanced and/or contain high levels of some minerals that can be toxic to sheep if fed as a high proportion of the diet. In particular, sheep are more susceptible to high levels of copper than cattle or goats due to the way that they store and release copper. Acute poisoning may follow intakes of 20–100 mg of copper/kg in sheep. Chronic poisoning of sheep may occur with daily intakes of 3.5 mg of copper/kg when grazing pastures that contain 15–20 ppm (dry matter) of copper and low levels of molybdenum. Feeds such as cattle pellets, palm kernel meal, some of the brewers' grains and distiller products and products that have been treated with fungicides (e.g. grape pomace and products produced in humid climates) can be high in copper and care should be taken in how much of these products should be included in a ration.

Most by-products and unusual feedstuffs should be used with caution and introduced into rations gradually, even when low prices favour their use. Factors to consider about unusual feedstuffs are: their nutritive value, palatability, possible toxicity or contamination with pesticides or heavy metals and the effects upon digestion and utilisation of the total ration. The use of by-product stockfeed needs to be declared when completing National Vendor Declaration forms.

SAFEMEAT, a partnership between the red meat and livestock industries and Commonwealth and State Governments, has prepared residue risk information sheets on the use of unusual feedstuffs. Producers can obtain copies of these risk assessments from the SAFEMEAT website at safemeat.com.au/our-system/responsible-chemical-use/residue-risk/

High moisture content feeds

Stock can eat up to about 3.5 per cent of their live weight per day when the feed is in a dry form, such as hay or grain, but they cannot eat as much dry matter if the feed has a high moisture content.

Fresh, high-moisture feeds are often quite palatable to livestock but most of these feeds will ferment and sour quickly unless they are dried or ensiled.

Blending and levels of feeding

Many unusual feedstuffs can be a reasonable source of energy for the livestock – but quality can be variable. It is important that any new feedstuff be gradually introduced to livestock over a period of about two weeks.

As a rule of thumb, most unusual feedstuffs can be effectively incorporated into livestock rations to a maximum of about 30 per cent of the total ration without significant influence on animal health.

Types of feeds

Stock feed is usually categorised as either concentrates (high in energy or protein) or roughage (higher in fibre, but lower in energy). Protein concentrates generally contain more than 20 per cent crude protein.

By-product energy concentrates

Almond hulls

Almond hull products vary considerably due to varietal differences and harvesting procedures. Soft almond hull, having about 10 per cent fibre and about 85 per cent of the energy value of barley grain, is a good feed. However, some supplies are contaminated with sticks, dirt, hard shells and other foreign materials at harvest time. This greatly reduces their feeding value and acceptability to livestock.

Almond hulls can be used as a partial roughage replacement when supplies are short and hay and straw prices high.

When mixed with other ingredients in commercial concentrate mixes, almond hulls usually are restricted to 20 per cent or less to maintain high nutrient levels and palatability of the concentrate mix. In complete feedlot rations, almond hulls are limited to about 30 per cent or less.

Figure 8.1: Almond hulls.

Apple pomace

Apple pomace is the by-product of apples used for cider or vinegar production. It can be fed fresh, ensiled or dried.

Two problems have hampered feeding of apple pomace. Pesticide contamination has been a problem in some areas, making the pomace unacceptable in dairy and (occasionally) sheep and beef rations. A second difficulty is that urea or other non-protein nitrogen compounds should not be fed with apple pomace due to the possibility of abortions or abnormalities in offspring.

Apple pomace is a highly palatable feed, medium in energy but very low in protein and fibre. In a balanced ration, it can replace up to about one-third of the concentrates used, and make up 15–20 per cent of complete feedlot rations.

Bakery waste

Large amounts of unsold bread, doughnuts, cakes and other pastries are available in some areas and are excellent energy sources for ruminant rations. Bakery waste, however, may potentially contain meat or other animal protein and so should be used with caution and in accordance with ruminant feed ban legislation.

It is usually high in fat and low in crude fibre. Protein levels (on a dry-matter basis) in the range of 10–12 per cent are typical. The low fibre content of the baked material and the baking process itself result in a feed that tends to stimulate ruminal propionate and reduce ruminal acetate production. This is desirable for feedlot livestock being fattened for market.

Up to about 10 per cent can be included in feedlot rations when supplies and economics are favourable. Supplies should be fed quickly to prevent spoilage.

Brewers' grains

Brewers' grains have 20–25 per cent crude protein (on a dry matter basis), making them a good protein source in addition to their energy value. They do increase the likelihood of acidosis due to a combination of low fibre, soluble carbohydrate and being naturally acid.

The brewing process makes the protein less soluble than that from many protein supplements. This could be valuable in rations, such as silage supplement with non-protein nitrogen, that contain large amounts of soluble protein.

Brewers' grains are fed both wet and dried. Dry, they have about 80 per cent of the energy value of barley grain (the energy value varies depending on the brewery and additives used in the brewing process). They are not as palatable in the dried form as the original grain and usually are included as 25 per cent or less of a dairy concentrate mix and 1–20 per cent in feedlot rations.

Citrus pulp

Citrus pulp is classified as a concentrate but is also valuable as a partial roughage replacement because of its high level of digestible fibre.

It commonly contains about 15 per cent crude fibre in the dry matter. Its energy value is about 94 per cent the value of barley grain. It has only about 7 per cent crude protein in the dry matter.

Citrus pulps can be fed fresh or as silage. Both are very acceptable to stock but pulp and peels from lemons are somewhat more acceptable than those from oranges and grapefruit.

Transportation costs preclude the wet pulp being fed at a distance from processing plants.

Citrus pulp is usually fed dehydrated. It must be introduced gradually into a ration to let stock get accustomed to its distinctive smell and taste. Levels up to 15–20 per cent are acceptable in feedlot rations.

Citrus pulps are high in calcium and low in phosphorus, and aggravate the high calcium-to-phosphorus ratio in a ration when fed with legumes such as lucerne. Feeding citrus pulp to ewes close to lambing may predispose them to hypocalcaemia.

Figure 8.2: Citrus pulp.

Fats and oils

Fats and oils have an energy value about 2¼ times that of carbohydrates. Fats are also used to settle the dust and as a lubricant for feed processing.

About 2–5 per cent fat is an acceptable level in commercial feedlot rations. Take care to ensure the fats and oils are not contaminated with extraneous chemical during collection, storage and use. Tallow and used cooking oil may only be used in accordance with ruminant feed ban regulations.

Grain screenings

Grain screenings result from the cleaning of small grains before they are milled for human consumption. The best grade of screenings consists primarily of broken and shrunken kernels of grain, wild oats and other palatable weed seeds. When ground, good screenings approach grain in feeding value and have been used as 25 per cent or more of concentrate mixed and 15–20 per cent in feed rations. However, light, chaffy screenings are much higher in fibre and resemble straw more than grain in feeding value. Such screenings should be restricted to 10 per cent.

Molasses

All types of molasses are good energy sources but are low in protein. In feedlot rations, up to 15 per cent is an acceptable level.

Molasses and urea have been added to poor-quality straw to improve both palatability and protein levels when straw is the main component of a diet, but should be viewed only as a maintenance feed for adult dry stock.

Onions

Onions have been fed successfully to sheep and cattle and they eat them readily. They can cause anaemia in sheep so introduce them over a period of time and only up to 50 per cent of the total ration.

Rice bran

Rice bran results from the processing of rice grain for human consumption. Besides the bran itself, it contains the germ from the grain and fragments of the hull not removed in milling. Levels of up to 15 per cent have been fed successfully to livestock. At these levels, it is roughly equivalent to wheat bran in nutritional value.

Tomato pomace

Tomato pomace is comparable to good-quality hay, on a dry matter basis. Variability, especially in moisture content is one of the main problems associated with the use of this by-product feed. Dry matter has been shown to vary between 11.9 and 27.5 per cent. Pesticide contamination can also be a problem with tomato pomace.

Wheat bran and other wheat by-products

Wheat bran consists of the coarse outer coatings of wheat kernels. It is a bulky feed that is relatively high in protein and phosphorus. It is highly palatable to livestock and is utilised efficiently when included up to 25 per cent of the concentrate mix. About 10–20 per cent of wheat bran and other wheat by-products can be used in feedlot diets.

By-product protein concentrates

Many crops grown for oil production also produce by-products high in protein. These by-products are sometimes included as a protein source in livestock rations. Some have high fat levels and should not be fed as the whole diet. Inclusion rates in rations are limited by protein requirement of the class of stock being fed.

By-products include: coconut meal, corn gluten meal, cottonseed meal, linseed meal, safflower meal, soybean meal and sunflower meal.

Other by-products such as distillers' grains are used extensively as protein supplements in livestock rations. Brewers' grains, previously discussed as an energy feed, are also relatively high in protein. Having been through a manufacturing process, the protein is often denatured, making them useful sources of by-pass protein suitable for high-performing dairy cattle or higher growth rates in growing cattle and lambs.

Canola meal

Canola meal has become available with the increase in plantings of canola, and is commonly used in rations for high-producing dairy cattle. The protein level ranges from 32 to 40 per cent.

Coconut (copra) meal

Coconut meal, popularly known as copra, is one of the most palatable feeds available for livestock.

It is high in energy and contains about 20 per cent protein. Rancidity can be a problem during storage if the meal is high in fat but high-fat copra contains considerably more energy than copra produced by the solvent process.

Cottonseed meal

Cottonseed meal is a by-product of the production of cotton lint and cottonseed oil. It contains about 40 per cent protein and is well liked by livestock.

The amount of oil left in the meal influences its energy value (amounts vary according to the method of processing). However, energy levels are somewhat lower than those found in some other protein supplements such as coconut meal, soybean meal and linseed meal.

Cottonseed meal contains gossypol which interferes with many cellular processes, and poisoning is cumulative over time. Young calves are particularly sensitive, but the total amount in the ration for ruminants (over 4 months) should be limited to 1,000 ppm. Goats appear to be more sensitive than cattle or sheep.

Figure 8.3: Whole cottonseed.

Linseed meal

Linseed meal, the by-product of the extraction of linseed oil from flaxseed, is an excellent protein supplement for livestock. Protein content varies from about 30 to 38 per cent, depending on the source and processing method. When reasonably priced, it can be used as the only protein supplement in livestock rations because it is very palatable.

Occasionally the meal may contain excessive levels of prussic acid, resulting in cyanide poisoning in ruminants.

Poultry litter and manure

Feeding of poultry waste (litter and or manure) to stock is prohibited under the Australian ruminant feed ban.

> The ruminant feed ban prevents the feeding of ruminant products such as meat, bone meal, feather dust and litter back to ruminants, to limit the possible transmission of the prions of Transmissible Spongiform Encephalopathy ('mad cow disease' and 'scrapie' in sheep). Pig and poultry feeds contain animal protein to supply the essential amino acids not found in plants: ruminants make these themselves.

Safflower meal

Safflower meal has increased in availability and importance as a protein supplement in recent years because of the popularity of safflower oil in human diets. Safflower meal from unhulled seeds has about 20 per cent protein, is high in fibre and relatively low in energy. Meal made from well-hulled seeds has about 40 per cent protein and is much higher in energy.

However, safflower meal from either source is not as palatable to livestock as the more common protein supplements and is usually restricted to 20 per cent or less of concentrate mix.

Soybean meal

Soybean meal contains 40–50 per cent protein, is high in energy and is highly palatable to livestock.

Sunflower meal

Protein levels vary from 20 to 25 per cent, depending on the processing method and whether the seed is hulled or not. It is roughly equivalent to cottonseed meal as a protein supplement for livestock.

Whey

Whey is the residue from cheese production and consists primarily of lactose, minerals and water. It can be fed dry or liquid. Pollution control regulations and the high cost of drying have resulted in increasing amounts being used as liquid feed where transport costs are not prohibitive.

Dried whey is a major component of many dry milk replacers fed to calves. It is usually too expensive to be included in rations for older animals, but sometimes is included at low levels in pelleted feeds because of its binding characteristics and nutrients.

Liquid whey contains only 6–7 per cent solids and must be fed quickly or it will spoil. In cool climates, it can be stored for 3–4 days before feeding. In warm climates, it should be fed the same day it is delivered.

Liquid whey is frequently available for only the hauling costs, making it an inexpensive source of nutrients for animals near cheese plants. However, supplies are often variable and storage of whey attracts fly problems.

By-product roughage

Canola hay and silage

Canola hay and silage are likely to be available as a fodder source in droughts where there has been frost damage. In these situations it is likely that lengthy withholding periods will apply (15 weeks in some situations, e.g. when pre-emergent herbicides have been used). Commodity Vendor Declarations must be sought from feed suppliers to manage the risks.

There have been reports of nitrate poisoning from canola products and it is recommended that canola hay or silage is not fed as a sole ration or to hungry animals.

Rice hay

Rice hay is generally a good, palatable roughage of equivalent feed value to cereal hays. It contains significant levels of silica and oxalate, both of which may predispose animals to urinary calculi.

If rice hay is fed as the roughage in a hay and grain diet, feed 1.5 per cent limestone and 1 per cent salt to correct the calcium:phosphorus balance in the ration and promote water intake.

Rice hay can contain a range of weeds, such as umbrella sedge, barnyard grass, star-fruit and wild millet.

Seaweed

Kelp is the most common type of seaweed that might be available for feeding. The dry matter of kelp contains about 30 per cent minerals (compared to 5–6 per cent in hay, pasture, etc). Seaweed is sometimes used as a mineral source for livestock. Kelp contains 0.15–0.2 per cent iodine.

Kelp can be fed quite satisfactorily at up to about 25 per cent of the diet of livestock. The rich mineral content of seaweed, especially salt, can make the material quite palatable to livestock.

Poor quality by-products

Grape pomace or marc

Grape pomace or marc is the refuse in the production of grape juice and wine. It consists mainly of grape seeds, stems and skins. It has low feed value and is variable in energy, protein and dry matter so is considered only as a filler to reduce the price of a concentrate mix. With new harvesting and winery techniques, grape pomace containing few or no stems can be produced. This waste feed has been fed successfully to a 15–20 per cent level in complete feedlot rations.

Grape marc has been found to be extremely palatable to sheep. Lambs in pen trials have consumed 350 g/head/day when fed with straw. This diet was effective in reducing weight loss only.

Studies have shown that oil-soluble chemicals in grape seeds may appear at levels that would result in excessive residues in animal fat when fed. There are also concerns about residual levels of copper, which can be toxic to stock (especially sheep), used in fungicides on grapes.

Figure 8.4: Grape pomace.

Rice hulls

Rice hulls have practically no feed value but can be useful as bedding material for livestock.

They are high in crude fibre and silica, and the fibre is largely indigestible. However, up to 15 per cent of unground rice hulls can be included as a roughage source in drought rations being fed to livestock.

Sawdust

Sawdust has virtually no feed value for sheep or cattle due to its high level of lignification, although it has been shown to be useful when feeding high-concentrate diets to sheep or cattle during droughts. Sheep survival rates in drought have been shown to be better when 15–20 per cent sawdust (hoop pine and spotted gum) was included in the wheat rations. Coarse sawdust was better than fine sawdust in maintaining rumen function. Sawdust from treated timber should not be used.

Treating straw with urea

Where straw is widely available and relatively cheap there has been some success in improving the nutritional value by adding urea. This can improve the protein level significantly (e.g. 2–14 per cent) but the urea-treated straw is low in energy and will require supplementation with grain or other high-energy ration.

To treat 1 tonne of straw, dissolve 50 kg of urea fertiliser in 850 litres of water and spray the solution onto the straw. The straw needs to be contained airtight (covered in plastic) and left for 7–10 days in summer (longer in winter). Animals will take a while to adapt and caution must be exercised to avoid urea toxicity.

Waste paper

Waste paper has little or no feed value for sheep or cattle. Due to its poor feed value and the risk of contaminants such as lead, cadmium, polychlorinated biphenyls and other toxic substances, feeding waste paper to sheep or cattle is not recommended.

Table 8.1: Feed quality values, feeding risks and management of less commonly used forage supplements.

Fodder	Quality Values (Range in brackets)				Risks	Management
(No. of samples)	DM%	MJ ME/ kg DM	CP%	NDF%		
Canola silage (135)	47.2 (22.8–88.1)	10.2 (6.9–12.4)	17.9 (8.8–33.4)	38.0 (23.4–58.7)	Potential nitrate and sulphur (S) toxicity. S-methyl cysteine sulphoxide (SMCO) toxicity causing haemolytic anaemia. Occasional 'brassica-type' problems. Oil content high if pods forming.	Introduce slowly to well-fed animals, i.e. not hungry. Limit intake to ¼–⅓ of diet to avoid toxicity-related problems. Watch stock for 'brassica-type' signs of respiratory distress, photosensitisation, blindness and sudden excitability, digestive problems, pulpy kidney and bloat. Total S intake to be less than 0.4% of diet DM. If silage is very dark in colour and foul smelling, probably too wet at ensiling. Note potential for low (and high) quality.
Canola hay (708)		9.5 (3.9–13.1)	15.1 (5.9–27.7)	41.1 (21.7–69.1)	Fire risk and mouldy hay. Thicker stems may not be eaten. Rumoured to be capable of puncturing rumens. Oil levels high if pods forming.	Visually inspect hay for mould. Stems may have been too wet at baling. Inspect hay for high levels of leaf loss. Rumen damage unlikely. Preferable if hay was roller/super conditioned prior to baling to crush stalk or if chopped short at feed out.
Chicory (fresh)	NA	10.3 (8.0–12.3)	20.0 (7.6–32.4)	37.5 (27.2–48.4)	May become diseased if moisture is held in hollow freshly chewed/cut stems.	Avoid grazing during wet winter weather to avoid disease build up from water held in plant crowns. Graze before stems become hollow. Do not slash/cut plants if stems becoming hollow.
Millet silage (31)	41.2	9.7 (8.5–11.6)	14.4 (5.9–26.6)	58.2 (44.0–65.0)	Nitrate poisoning.	No sorghum prussic acid-type problems but nitrate poisoning can still occur in stressed plants.
Millet hay (34)	79.9	8.5 (5.5–10.6)	8.7 (2.5–23.3)	66.2 (48.3–80.1)	Nitrate poisoning.	No sorghum prussic acid type problems but nitrate poisoning can still occur in stressed plants.
Native pastures (63)	72.9 (30.5–93.6)	5.8 (3.9–9.4)	5.5 (0.5–18.9)	Not Available	Low nutritive value.	Best quality if cut when leafy very early in season.
Pea hay (40)	84.9	9.7 (5.1–11.6)	14.9 (4.5–21.6)	42.9 (29.1–70.8)	Mould in pods.	Quality will vary according to leaf loss, presence of disease and mould.
Sorghum silage (64)	NA	8.1 (3.2–10.5)	9.8 (2.1–18.2)	62.3 (52.7–79.1)	Potential nitrate poisoning and prussic acid (actually hydrogen cyanide or HCN) poisoning in stressed plants. Sorghum plants are low in sulphur content.	Drought, frost, high nitrogen and low phosphorous levels increase risk of prussic acid poisoning. Greater risk in fresh regrowth. Avoid cutting/grazing under about 0.75–1 m height. Crops mower-conditioned and chopped into silage will have reduced levels of prussic acid but slightly higher levels in baled silage. Stress can cause nitrate poisoning, being highest in bottom ⅓ of stem. Ensiling will reduce N levels substantially but be wary. Introduce partly gut-filled animals slowly to sorghum forage or silage slowly. Add sulphur salt blocks when ration is largely sorghum only.

Table 8.1: Feed quality values, feeding risks and management of less commonly used forage supplements (Continued).

Fodder	Quality Values (Range in brackets)				Risks	Management
(No. of samples)	DM%	MJ ME/ kg DM	CP%	NDF%		
Sorghum hay (132)	NA	9.0 (6.8–10.4)	9.9 (1.7–18.7)	62.2 (45.3–75.8)	Potential nitrate poisoning and prussic acid (actually hydrogen cyanide or HCN) poisoning in stressed plants. Sorghum plants are low in sulphur content.	See comments for sorghum silage for causes of prussic acid and nitrate poisoning. Haymaking will not markedly reduce prussic acid or nitrate poisoning risks. Super-conditioning may reduce prussic acid poisoning slightly. Introduce partly gut-filled animals slowly to sorghum forage or silage slowly. Avoid making hay with stressed plants. Add sulphur salt blocks when ration is largely sorghum only.
Straw: rice (7)	85.2 (52.2–93.5)	6.7 (5.3–8.9)	4.0 (1.9–5.0)	63.4 (53.4–68.5)	Low nutritive value. Contains silica and oxalate.	High levels of silica can predispose animals to urinary caculi.

Table 8.2: Feed quality values, feeding risks and management (where available) of less commonly used feed supplements.

By-Product Energy/ Protein Concentrates (No. of samples)	Quality Values (Range in brackets)				Risks	Management
	DM%	MJ ME/ kg DM	CP%	NDF%		
Acorns	70	7	5			
Almond hulls (milled or unmilled)	90 (88–92)	10 (8.5–10.5)	5 (4–6)	35 (30–45)	Low effective NDF	By-product of almond processing. Consists of the outer covering but not the hard shell. Higher NDF values refer to higher proportion of outer hull. Lower effective NDF if milled. Can be fed up to ~10% of total DM intake.
Apple pomace					Pesticide contamination. Do not feed with urea or other non-protein nitrogen compounds as can cause abortions or abnormalities in the offspring.	Can make up to one third of the concentrates in a ration and 15–20 per cent in a complete feedlot ration.
Apples	17	10	3			
Apricots, dried	90	12	6			
Bakery waste Bread	61	14	16	Low	Risk of acidosis (grain poisoning). Often high in fat and low in fibre. Do not feed breads that contain meat or animal protein (e.g. pizza breads)	Introduce slowly to avoid acidosis. Limit intakes to about 10% of diet. Other wastes, e.g. donuts, cakes, biscuits may differ slightly in nutrient value so obtain a feed analysis. Feed supplies quickly to avoid spoilage.

Table 8.2: Feed quality values, feeding risks and management (where available) of less commonly used feed supplements (Continued).

By-Product Energy/ Protein Concentrates (No. of samples)	Quality Values (Range in brackets)				Risks	Management
	DM%	MJ ME/ kg DM	CP%	NDF%		
Bananas	24	13	4			
Brewers' grain (105)	31.7 (13.9–93.0)	10.5 (7.7–11.9)	21.9 (16.9–35.2)	755.1 (41.6–61.6)	Fat 8.0% (3.7–12.2)	Introduce slowly at less than 25% of a ration. May be expensive to transport due to low DM%. May be difficult to store and feed. Fat levels can be high but not normally a problem.
Broccoli	11	10	33			
Brussel sprouts	15	11	33			
Buckwheat	87	11	12			
Cabbage	9	13	25			
Cabbage leaves	15	10	14			
Canola meal	91	12 (10–16)	38 (27–42)			
Carrot pulp (9)	10.0 (8.0–15.5)	12.7 (8.8–14.2)	9.8 (6.5–15.3)	27.6 (26.1–29.1)	Potential risk of acidosis.	May be expensive to transport due to low DM%.
Carrots	13	12	10			
Cauliflower	9	10	30			
Citrus pulp (19)	14.3 (10.6–17.3)	12.7 (9.6–14.5)	8.6 (6.0–11.9)	25.1 (17.9–34.1)	High Ca:P ratio	Introduce slowly. Composition varied depending on fruit type and whether peels and seeds included. High-energy feed but can be low in CP, NDF and DM content. Commonly mixed with silage, hay and grain as a fully balanced ration. Ideally fed in troughs or on a feed-pad. Can be difficult to store and feed unless set-up for it. Distinctive smell and taste. Can be expensive to transport. High in calcium (Ca) and low in phosphorus (P) so should be counter-balanced by other feeds low in calcium and high in phosphorus.
Citrus pulp Silage (3)	15.6 (15.1–16.5)	11.9 (10.5–13.1)	9.5 (8.9–9.8)	NA		As per citrus pulp comments. Can be unstable after opening so feed out quickly. Use inhibitor additive at ensiling. Can be ensiled with other products
Chocolate by-products (9)	91.3 (53.4–98.1)	15.6 (14.1–17.9)	7.0 (0.1–11.0)	NA	Fat % 18.7 (7.0–29.8) Note wide range in DM, ME and CP and potential of very low CP and high fat content.	Potential risks of acidosis unless feed is introduced slowly and feeding rate is increased slowly. Must be fed in conjunction with a fibre source and some additional protein. Feed no more than 5% oil in total DM ration. Note potential of wide variation in fat content depending on chocolate source
Choc malt mix	94	14	24	35	May be difficult to manage, store and feed out. Potential risk of acidosis.	High-quality blend of sugar, starch, protein and fibre. Introduce and increase feeding rates slowly. Very palatable, but may be difficult to manage, store and feed out, particularly under warm conditions.

Table 8.2: Feed quality values, feeding risks and management (where available) of less commonly used feed supplements (Continued).

By-Product Energy/ Protein Concentrates (No. of samples)	Quality Values (Range in brackets)				Risks	Management
	DM%	MJ ME/ kg DM	CP%	NDF%		
Corn cobs, ground	90	7	3			
Cottonseed meal, 41% protein, mechanically extracted	93	3	44			
Cottonseed meal, 41% protein, solvent extracted	91	11	46			
Cottonseed, whole	92	14	23			
Dried Distillers' Grain with Solubles (DDGS) (1)	88–90	13.7	24	30		By-product of distiller industries. Is condensed and dried stillage remaining after starch fermentation of wheat to produce for bio-fuels in combination with yeast and enzymes. From this process DDGS is the coarse grain + condensed thin stillage (syrup) dried. Can make to 20% by DM of ration.
Dried Distillers' Grain (DDG)	90–92	12.5–13.6	27–30	27–29	Very high crude protein Low NDF	By-product as above. DDG is coarse grain particles only dried without the condensed thin stillage. Very high protein so useful when pasture protein is low, etc. Be mindful of slightly low NDF value. Can constitute ~20–30% of ration DM.
Condensed Distillers' Solubles/ Syrup) (CDS)	42	15	18	2.1	Risk of acidosis (grain poisoning).	By-product as above. CDS is the syrup material left after wheat (mainly) fermentation product (stillage) has been evaporated. Very high ME and negligible fibre (NDF) so ensure enough fibre in ration.
Grape marc: Raw (117)	55 (19.6–93.9)	6.5 (2.3–12.1)	12.2 (5.4–18.5)	47.6 (20.3–60.6)	6–10% oil. May contain high copper levels.	Note huge range in DM, ME, CP and NDF. This data probably also contains some Pressed grape marc data. High tannins in grape marc tend to bind much of the protein so allow for lower CP levels in rations. May be difficult to store and feed. May contain fungicide residual. Feed up to ~10% DM of whole ration.
Grape marc: Pressed	50	10	13	33	May contain high copper levels.	Excess alcohol (ethanol) removed by distillation compared to raw grape marc from wine industry. See other comments for raw grape marc.
Grape marc silage: Raw (3)	35.8 (28.1–46.4)	8.1 (4.3–11.1)	17.9 (11.7–23.3)	NA	May contain high copper levels.	See comments for raw grape marc.
Grapefruit	14	13	8			

Table 8.2: Feed quality values, feeding risks and management (where available) of less commonly used feed supplements (Continued).

By-Product Energy/ Protein Concentrates (No. of samples)	Quality Values (Range in brackets)				Risks	Management
	DM%	MJ ME/ kg DM	CP%	NDF%		
Kelp, dried	91	5	7			Rich mineral content. Contains 0.15–0.2 per cent iodine.
Lemon pulp, dried	93	12	7			
Lettuce	5	8	22			
Linseed meal, 36% protein, solvent extracted	90	12	38		May contain excessive levels of prussic acid, resulting in cyanide poisoning in ruminants.	
Linseed meal, 37% protein, mechanically extracted	91	12	38		May contain excessive levels of prussic acid, resulting in cyanide poisoning in ruminants.	
Melons	4	11	11			
Milk (cattle), skim, dried	94	13	36			
Milk (cattle), whole, dried	94	15	27			
Milk, colostrum	25	15	46			
Molasses, cane	75	11	6			
Oat hulls	93	5	4			
Oats, sprouted 5 days	13	10	18			
Onions	11	13	10		Anaemia	Slow introduction.
Orange pulp. dried	88	12	8			
Orange pulp, wet	25	12	9			
Oranges	13	12	7			
Palm kernel expeller meal (PKE)	94 (92–96)	11.1 (9.3–12.4)	15.7 (14.8–16.3)	65 (55.4–74.2)	7–9% oil, but unsaturated and low potential for problems. Potential for compaction in rumen. Ca:P ratio is low as is sodium (Na). Has high copper levels. Low effective fibre.	Introduce slowly to stock to enable adaptation. May be unpalatable initially so mix with other feeds. May be mixed with grain prior to feeding. Store in silos with smooth sides and steep coned with large opening to avoid blockages. NDF is ineffective so ignore high value in table. Place water + hay/straw well apart from PKE to reduce potential for rumen compaction. Ca and Na may need to be supplemented if PKE is fed at high levels.

Table 8.2: Feed quality values, feeding risks and management (where available) of less commonly used feed supplements (Continued).

By-Product Energy/ Protein Concentrates (No. of samples)	Quality Values (Range in brackets)				Risks	Management
	DM%	MJ ME/ kg DM	CP%	NDF%		
Peaches	10	12	9			
Peanut meal, mechanically extracted	93	12	52			
Peanut meal, solvent extracted	92	12	52			
Peanut skins	94	10	17			
Pears	17	13	6			
Pineapples	15	12	3			
Potato mash (45)	23.1 (10.9–62.3)	13.3 (10.8–14.8)	11.2 (6.7–25.8)	NA	About 2% oil. Potential risk of acidosis	Wide range in moisture, ME and CP. Very high in starch and therefore highly digestible. Potential risks of acidosis unless levels introduced and increased slowly. Must be fed in conjunction with a fibre source and some additional protein.
Potato meal, dried	91	12	11			
Potato slivers	20	14	6	11	Potential risk of acidosis.	See comment for potato mash.
Pumpkins	9	13	16			
Raisin pulp, dried	89					
Raisins, cull	85	7	4			
Rice bran	90	14 (9–15)	16 (13–20)			Levels of up to 15 per cent have been fed successfully to livestock. Roughly equivalent to wheat bran.
Soyabean meal	85 (12–94)	15 (13–16)	44 (30–54)			
Sunflower meal	91	10 (8–14)	34 (20–39)			
Tomato pulp (9)	27.3 (16.6–30.2)	7.7 (4.1–9.3)	19.4 (5.0–22.6)	58.8 (1 sample)	Pesticide residues	Wide range in moisture and ME.
Whey	8 (2–27)	14 (12–14)	30 (20–40)			Liquid whey is very low in dry matter and needs to fed the same day delivered in warm climates.

Further information

- SAFEMEAT website – Risk assessments of a number of feed sources (and other information on safe meat): safemeat.com.au/our-system/responsible-chemical-use/residue-risk/
- Australian Fodder Industry Association – Vendor Declaration: afia.org.au/vendor-declaration-form/
- Vendor declaration form available from Integrity Systems. integritysystems.com.au/on-farm-assurance/national-vendor-declaration-nvd/
- Mineral content of common stock feeds: www.dpi.nsw.gov.au/__data/assets/pdf_file/0018/180621/mineral-content-of-common-ruminant-stockfeeds-crops-and-pastures.pdf
- FeedTest website – Services for other services that include minerals, heavy metals, pesticides, residues, etc: www.feedtest.com.au/index.php/services/other-services
- Nutrient Requirements of Domesticated Ruminants. Edited by M. Freer, H. Dove and J.V. Nolan. CSIRO.