

## TOXINS OF PLANT ORIGIN IN ANIMAL FEEDSTUFFS

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Many plant components have the potential to precipitate adverse effects on the productivity of farm livestock. These compounds are present in the foliage and/or seeds of virtually every plant that is used in practical feeding. Typical concentrations for selected toxins are presented in Table. Plant toxins may be divided into a heat-labile group, comprising lectins, proteinase inhibitors and cyanogens, which are sensitive to standard processing temperatures, and a heat-stable group including, among many others, antigenic proteins, condensed tannins, quinolizidine alkaloids, glucosinolates, gossypol, saponins, the non-protein amino acids S-methyl cysteinesulphoxide and mimosine, and phyto-oestrogens.

### Lectins

Lectins are proteins capable of damaging the intestinal mucosa. In contrast to most other dietary proteins, lectins resist digestive breakdown and substantial quantities of ingested lectins may be recovered intact from the faeces of animals fed diets containing one of a number of legume seeds. The prime example of a lectin with potent antinutritional and toxic properties is concanavalin A, a component of the jack bean. Lectins are also present in other legume grains including the winged bean and soybean. Concanavalin A enhances the shedding of brush-border membranes and decreases villus length, thereby reducing surface area for absorption in the small intestine. With other lectins, the lamina propria of the intestine may become infiltrated with eosinophils and lymphocytes. The overall effect is reduced nutrient absorption, but immune function may also be impaired.

### Proteinase inhibitors

The proteinase inhibitors are typical examples of heat-labile factors with antinutritional activity. They constitute a unique class of proteins with the ability to react in a highly specific manner with a number of proteolytic enzymes in the digestive secretions of animals.

The trypsin inhibitors of soybean are now well characterized and are important determinants of nutritive value. Proteinase inhibitors are also present in other leguminous seeds such as field beans, winged beans, pigeon pea and cowpea. Effects in animals include reduced protein digestion and endogenous loss of amino acids, with the overall result that performance is impaired.

### **Cyanogens**

Cyanogens occur widely in plants and in diverse forms. In sorghum and cassava, the predominant cyanogens are, respectively, dhurrin and linamarin. The latter compound is also present in linseed. Cyanogens are glycosides that readily yield HCN and it is this latter molecule that causes dysfunction of the central nervous system, respiratory failure and cardiac arrest. Metabolizable energy values for poultry tend to be lower in untreated cassava rootmeal, presumably because of its cyanogenic potential.

### **Condensed tannins**

Tannins belong to a group of phenolic compounds with a molecular weight in excess of 500 daltons. Condensed tannins (CTs) are a subset of this group and are widely distributed in leguminous forages and seeds and in sorghum. Cattle and sheep are sensitive to CTs, when CTs, including those in lotus or in browse legumes such as *Acacia* species, comprise a significant part of their diets. Primary effects include impaired rumen function and depressed intake, wool growth and live-weight gain. However, at moderate levels (30 to 40 g/kg legume dry matter), CTs may result in nutritional advantages in respect of increased bypass protein availability and bloat suppression in cattle. At higher levels (100 to 120 g CTs/kg legume dry matter), reduced gastrointestinal parasitism in lambs has been reported.

### **Quinolizidine alkaloids**

The quinolizidine alkaloids occur in lupins and include lupinine, sparteine and lupanine. Bitter cultivars contain relatively high levels of total alkaloids and are not suitable as animal feedstuffs because of their negative effects on intake. In addition, cattle consuming certain lupin species during pregnancy may produce calves with multiple congenital deformities.

### **Glucosinolates**

Glucosinolates are glycosides of particular significance in brassica forage crops such as kale. Removal of glucose from glucosinolates by plant or microbial enzymes (myrosinase), results in the release of a diverse array of compounds which undergo further breakdown to yield a

number of toxic metabolites. The most common breakdown products are isothiocyanates and nitriles but, depending on such conditions as pH, temperature and metallic ion concentrations, a number of other metabolites may also be produced. These products may then cause organ damage, goitrogenic effects or reduced feed intake, particularly in non-ruminant animals.

### **Gossypol**

Gossypol pigment occurs in cottonseed in free and bound forms. In whole seeds, gossypol exists essentially in the free form, but variable amounts may bind with protein during processing to yield inactive forms. Free gossypol is the toxic entity and causes organ damage, cardiac failure and death. Cottonseed meal fed to bulls can induce increased sperm abnormalities and decreased sperm production.

### **Saponins**

Saponins are divided into two groups: steroidal saponins, which occur as glycosides in certain pasture plants such as *Brachiaria decumbens* and *Panicum species*; and triterpenoid saponins, which occur in soybean and alfalfa. Many hepatogenous photosensitization conditions in sheep have been attributed to the intake of forage plants containing steroidal saponins. In contrast, triterpenoid saponins from alfalfa reduce feed degradation in the rumen.

### **Amino acids**

A wide range of non-protein amino acids occur in the foliage and seeds of plants. Forage and root brassica crops contain S-methylcysteine sulphoxide (SMCO), while the aromatic amino acid mimosine occurs in the foliage and seeds of the tropical legume *Leucaena leucocephala*. Uncontrolled feeding of brassica forage to ruminants causes organ damage with haemolytic anaemia, which is attributed to the intake of SMCO. Abrupt feeding of *Leucaena* to sheep causes shedding of fleece, reduced intake, organ damage and death. In cattle, loss of hair, excessive salivation, lethargy, weight loss and enlarged thyroids are common features of *Leucaena* toxicity.

### **Phyto-oestrogens**

Phyto-oestrogens are a diverse group of isoflavonoid compounds found primarily in forage and grain legumes. In clover, formononetin is the major form of phyto-oestrogen. Phyto-oestrogens are actively metabolized in the rumen to form products that vary in their biological activity. Formononetin is converted into a more oestrogenic compound. Phyto-



oestrogens have been associated with “clover disease” in sheep, which is characterized by low ovulation and conception rates.

