

**BIHAR ANIMAL SCIENCES UNIVERSITY**

**BIHAR VETERINARY COLLEGE, PATNA**

**Department of Animal Nutrition**

**Class: M.V.Sc.**

**Course No.: ANN-609, Unit-II**

**Date: 05.12.2020 & Time: 10.0-11.0 AM**

**Classification of toxic principles in animal feedstuffs  
(Part-1)**

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## **Point to be discuss.....**

- **Anti-nutritional factors**
- **Classification of Harmful Natural Toxicants by chemical structure**
  - ✓ **Alkaloids**
  - ✓ **Glycosides**
  - ✓ **Proteins**
  - ✓ **Amino Acids and Amino Acid Derivatives**
  - ✓ **Metal binding substances**
  - ✓ **Mycotoxins**
  - ✓ **Phenolic compounds**
  - ✓ **Other toxins**
- **Classification of natural toxicants by their occurrence in feeds**
- **Management of Toxicosis**
- **Common adulterants in feed and fodder**

## **Anti Nutritional Factors (ANFs)**

- **ANFs may be defined as those substances generated in natural feed stuffs during normal metabolism & by different mechanisms exert effects contrary to optimum nutrition.**
- **Harmful natural constituent is a substance which under practical circumstances can impairs animal metabolism & produce adverse biological or economic effects in animal production.**

# Classification of Harmful Natural Toxicants by Chemical Structure

## 1. Alkaloids :

- Alkaloids (alkali-like) are compounds that contain nitrogen, usually in a heterocyclic ring.
- They are usually bitter and toxic in nature.

Name	Source
Nicotine	Tobacco
Ricinine	Castor plant seeds
Atropine	Deadly nightshade
Cocaine	Leaves of coca plant
Jacobine	Ragwort
Strychnine	Seeds of <i>Nuxvomica</i>
Morphine	Dried latex of opium poppy
Solanine	Unripe potatoes and potato sprouts

## 2. Glycosides:

- It contains glycan (carbohydrate moiety) & a non-carbohydrate moiety (aglycone) joined with an ether bond.
- It is usually bitter substances.
- They are classified on the basis of structure & properties of the aglycone.

### *i. Cyanogenic glycosides:*

- They yield **hydrocyanic acid (prussic acid)** when hydrolysed.
- It is hydrolysed by **Beta-glycosidases** to release **HCN, glucose** and **benzaldehyde**.
- However, glycosides occur in **vacuoles** in plant cell and enzymes are found in the **cytosol**. So, damage to the plant results in the enzymes and glycoside coming together and producing HCN.

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- The hydrolytic reaction can take place in the rumen by microbial activity, hence, **ruminants are more susceptible to cyanogen toxicity than non-ruminants.**
- The HCN is absorbed and is rapidly detoxified in the liver by the enzyme **rhodanase** which converts CN to thiocyanate (SCN).
- Excess cyanide ion **inhibits the cytochrome oxidase** and **stops ATP formation**, tissues suffer energy deprivation and death follows rapidly.
- Drying of cyanogenic leaves may **reduce the risk of cyanide toxicity.**
- **Cattle are more susceptible to HCN poisoning than sheep, horse and pig.**
- **Immature green Jowar, sudan fodder and linseed may cause HCN toxicity.**

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- **Immediate treatment of cyanide poisoning:** Injecting i/v 3 g sodium nitrate & 15 g sodium thiosulphate in 200 ml distilled water for cattle & for sheep 1 g sodium nitrate & 2.5 g sodium thiosulphate in 50 ml H<sub>2</sub>O.
- Some glycosides such as Amygdaline (Almond), Dhurrin (Jowar and, Dhatura, immature grasses), Linamarin (Linseed, cassava, pulses).

## *ii. Goitrogenic glycosides:*

- It decreases production of the thyroid hormones (Thyroxine, T<sub>4</sub> & Tri-iodothyronine, T<sub>3</sub>) by inhibiting their synthesis by thyroid gland.
- As a result, the thyroid enlarges to compensate for reduced thyroxin output, producing goitre.

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- **Goitrogenic glycosides** are commonly found in Brassica spp. such as cabbage, turnip, kale, rapeseed, mustard green etc.
- Glucosinolates are formerly called thioglucosides.
- **Myrosinase** is released from plant tissue by crushing (mastication) & it also produced by rumen microorganisms.
- Glucosinolates are always accompanied by the enzyme **myrosinase** (thioglucosidase) which are capable of **hydrolyzing them to thiocyanates and isothiocyanates to s-allyloxazolidinethione** which is potently goitrogenic causes **depressed iodine uptake and liver damage**.
- **Ruminants are less susceptible than pig and poultry.**

### *iii. Coumarin glycosides:*

- Found in **sweet clover** (*Melilotus* spp.) as melilotoside.
- Coumarin is **converted by mould growth to dicoumarol** an **antagonist of vitamin K**.
- Sweet clover poisoning, caused by **feeding mouldy sweet clover hay**, is therefore an induced vitamin K deficiency.

### *iv. Steroid and Triterpenoid glycosides:*

#### **a) Cardiac glycosides:**

- Best known CG is **digitonin**, contained in foxgloves (*digitalis* spp.).
- Physiologically, they are **potent stimulators of heart rate & are used medicinally**.

## b) Saponin:

- Saponins are **glycosides** containing a polycyclic aglycone moiety of either C27 steroid or C30 triterpenoid (collectively termed as sapogenins) attached to a carbohydrate.
- They are **widely distributed in the plant kingdom**.
- Saponins are characterised by a **bitter taste** and **foaming properties**.
- **Erythrocytes lyses** in saponin solution and so, these compounds are toxic when injected intravenously.
- **In non-ruminants (chicks and pigs), retardation of growth rate, reduction in feed intake occurs & in ruminants, implicated in causing bloat**.
- The adverse effects of saponins can be overcome by repeated washing with water which makes the feed more palatable by reducing the bitterness.

**v. Vicine:**

- Vicine is a glycoside in Fava beans (*Vicia faba*).
- It causes haemolytic anaemia (favism) in people who have a genetic deficiency of glucose-6-PO4-dehydrogenase activity in their RBC.
- Fava beans are being utilized as a protein supplement for livestock.

**vi. Isoflavones:**

- Which are called phytoestrogens, contain a flavones nucleus (ex- genistein, formononetin & coumestrol).
- It cause reproduction problems in ruminant especially sheep.

### **3. Proteins:**

- **Several important inhibitors in plants are proteins.**
- **In some cases, effect of these are to inhibit the utilization of other proteins by animals.**

#### ***i. Protease (Trypsin) and Amylase Inhibitor:***

- **Inhibitors of enzymes, such as **trypsin, chymotrypsin, carboxpeptidases, elastase** appear in many food products (**legumes, cereals, potatoes** etc.).**
- **Adverse effects following short- and long-term ingestion of **raw soybean meal** (the richest source of dietary trypsin inhibitors) by mammals & birds on protein utilization & growth, attributed to presence of **trypsin inhibitors**.**

**Protease inhibitors fall into 2 main categories:**

**1. Kunitz inhibitor:** MW- 21.5 kilodalton with 2 disulfide bridges and possess specificity mainly against trypsin.

**2. Bowman-Birk inhibitor:** MW- 8 kilodalton with a high proportion of disulfide bonds & capability of inhibiting chymotrypsin & trypsin at independent binding sites.

- Levels of trypsin inhibitors (mainly as the Kunitz trypsin inhibitor) in soybeans have been reported to vary from 17-48 mg/g sample or from 37-123 mg/g protein.
- Protease inhibitors can be inactivated by the heat-processing method, such as extrusion, IR, micronizing, autoclaving, steam processing, or flaking.

## **ii. Hemagglutinins (lectins):**

- Hemagglutinins, are proteins which **agglutinate red blood cells**.
- **Soyabean lectin strongly binds to mannose of RBC & cause agglutination.**
- The **highest concentrations of lectins are found in seeds** but, in the leaves, their concentration is low due to translocation.
- Lectins may bind to the carbohydrate moieties of cells of the intestinal wall & cause a **non-specific interference with nutrient absorption**.
- **Robin**, a lectin from *Robinia pseudoacacia*, has been reported to cause symptoms of **anorexia, weakness and posterior paralysis in cattle**.
- **Ricin**, castor bean (*Ricinus communis*) seed press cake, and foliage are poisonous and not used as a livestock feed but the **oil is non toxic**.

### ***iii. Enzymes:***

- **Thiaminase**, found in **bracken fern** (*Pteridium aquilinum*) and **certain fish**.
- Enzyme cleaves the thiamine and **inactivating** it & causes **thiamine deficiency (Chastek's paralysis)**.
- Other enzymes in feeds which produce deleterious effects in livestock includes **Lipoxidases** in soybean & alfalfa, which **degrade fat soluble vitamin**.

## 4. Amino Acids and Amino Acid Derivatives

### (a) Mimosine:

#### ➤ Toxic amino acid

- A non-protein amino acid **structurally similar to tyrosine**, occurs in *Leucaena leucocephala* forage plant.
- Concentration of mimosine in the **leaf is about 2–6%**, varies with seasons & maturity.
- In **non-ruminant animals**, mimosine causes **poor growth, alopecia (loss of hair), eye cataracts & reproductive problems**.
- Levels of Leucaena meal above 5–10% of the diet for swine, poultry and rabbits result in poor animal performance.

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- **MoA of mimosine is not clear** but it may act as an amino acid antagonist or may **complex with pyridoxal phosphate**, leading to **disruption of catalytical action of trans-aminases**, or may **complex with zinc metal**.
- **Toxicity symptom in ruminants** are **poor growth, loss of hair & wool, swollen hooves, lameness, mouth & oesophageal lesions, depressed serum thyroxine level & goitre**.
- These symptoms may be due to mimosine toxicity & metabolite of mimosine in the i.e. **3, 4 -dihydroxypyridine (DHP)**.

### **(b) Avidin:**

- **Glycoprotein in egg albumin, which is an antagonist of B vitamin Biotin.**
- **Raw eggs can be used to induce biotin deficiency in experimental animals.**

**Discussions.....**

**Questions, if any.....??**

**THANKS**