

**FEED EVALUATION, FORMULATION AND PROCESSING
TECHNOLOGY
(AN – 304)**

CLASS LECTURES

for

FINAL EXAM (AN-304)

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OXALATE (Oxalic Acid)

Oxalic acid is a organic dicarboxylic acid that readily forms insoluble salts with macrominerals such as Ca, Mg, K. As for as complexing phenomenon is concern -- calcium and magnesium are more important.

Distribution

In both the vegetable and animal kingdoms oxalic acid is found in two forms; *free form* and *bound form* with salt. Plants which are particularly rich in oxalates include beet, spinach and a number of organic by products used as livestock feed ingredients.

- At gut level, it form complex with Ca and, thus Ca-oxalate complex limits Ca availability. If animal is fed on forage containing more oxalate contents (about 2%) --- then animal may suffer from -ve calcium level --- *Hypocalcemia* ----- result into: reduced gut motility which will ultimately reduce fee consumption. There is also low serum Ca level.
- Hence, overall animal's productivity is hampered.
- If serum Ca+ contents decreased → the proportion of other minerals like Na, K a, P increased.

Oxalate Poisoning Symptoms;

Oxalate poisoning in sheep and cattle are characterized by rapid and laboured respiration, depression, weakness, coma and death.

Inactivation of Oxalates

If sufficiently/proper heat treatment is done --- Complex forming ability of oxalates may be decreased.

Major problem is in ruminants which are fed on range land/pasture.

GLUCOSINOLATES

These are secondary plant metabolites. So far, about 120 glucosinolates have been identifies and these are very diverse in their biological response in animals.

Biological effects of Glucosinolates

- Depression of synthesis of thyroid hormone (Thyroxine and triiodothyronine), thus producing goiter. As these hormones have singinficant role in the metabolism of primary nutrients such as CH₂O, Fat and protein, thus all the metabolic pathways will be hampered and less precursors will be available for different metabolic activities.

- If protein metabolism is impaired – amino acid utilization will be hampered because amino acids go for i) protein synthesis ii) Hormone synthesis iii) Plasma protein synthesis.
- Glucosinolates limit the availability or incorporation of iodine to the precursors of thyroxine. These also interfere with the secretion of these hormones.

Biologically, glucosinolates are inactive substances but during crushing/cracking/processing, they become active and may convert into a variety of substances. During crushing/processing, an enzyme “Myrosinase” is liberated and results into conversion of inactive glucosinolates into a wide range of substances known as “**Aglucones**”. Aglucones are very unstable compounds – thus they are further converted into other products. A few of these aglucone derived compounds are;

1. **Goitorin**: is the most important aglucone derived anti-nutritional substance, that can depress the synthesis of thyroid hormone.
2. **Thiocyanate**: Interferes with iodine availability.
3. **Isothiocyanate**: bitter in taste, so unpalatable; lead to reduce feed consumption.
4. **Nitrils**: Imparts effects contrary to health --- -ve effect on liver, and kidney functions.
5. **Vinyl oxazolinidine thione**: induces physical and morphological changes in thyroid gland.

Degree of their adverse effects and type of compounds depend on various factors such as;

- i) Plant species
- ii) Agronomic practices
- iii) Climate conditions

Inactivation of Glucosinolates:

Heat treatment: is quite effective. Depending upon;

- a) type of compound present
- b) Heating duration
- c) Temperature

- Thiocyanate is more sensitive to heat but overall, efficiency of aglucones decreases on heat treatment.

Fates of Glucosinolates in the Animal body:

There are two fates; i) Absorbed in the intestinal lumen ii) or converted into other substances.

Severe effects of these anti-nutritional substances also depend upon the type of animals.

Ruminants: are more stable than non-ruminants due to well-developed ruminal flora. Ruminal microbes induce transformation in glucosinolates to its derivatives and their activity is also much reduced to great extent.

Growing Calves: have underdeveloped rumen; thus they are less stable for the effects of glucosinolate.

Poultry: Layers show more significant signs of glucosinolate toxicity than broilers because layers feed for longer time compared to broiler. Small quantities have no effect on poultry birds.

Hypothyroidism is associated with reduced productive performance by impairing thyroid glands.

GOSSYPOL

Gossypol pigments are polyphenolic compounds found extensively in the pigment glands of the cottonseed. At least 15 such pigments have been identified in extracts of both cottonseed meal and oil.

These pigments can exist either in a free form or as a gossypol-protein complex.

Concentration: whole seed contains a total of 1.09-1.53 g/100 gram of cotton seed meal; of which 0.19 g/100 g exists in the free form. All the biological activities of such pigments are due to presence of “aldehyde group” which form complex with protein. Among amino acid complex formation; gossypol-lysine complex is more common due to its stability.

Biological Effects of Free Gossypol

- Reduce oxygen carrying capacity of the blood
- Accumulation of fluids in the body cavities.
- Cardiac irregularity and shortened breath.
- Adverse effect on certain liver enzymes.

Remedy: i) Heat treatment ii) Screw press iii) Solvent Extraction method

CYANOGENS

These are the substances that have cyanide ion in their structure.

Distribution: High levels of cyanides can be found in certain grasses such as *jowar* (sorghum) and sudan grass, linseed, maize and cassava roots.

These plants generally contain cyanogenetic glycosides, which can be hydrolysed to prussic acid by the enzymes usually present in the same plant under a number of conditions during their growing period, or as they are being digested by animals.

These crops may develop toxic levels of prussic acid also known as hydrocyanic acid (HCN) in the new growth that follows either a period of drought, or a period of heavy trampling of physical damage by frost etc.

Effects:

- The hydrocyanic acid (HCN) is rapidly absorbed and some is eliminated through the lungs, but the greater part is rapidly detoxified in the liver by conversions to thiocyanate.
- Excess cyanide ion can quickly produce anoxia of the central nervous system through inactivating the cytochrome oxidase system and death can result within a few seconds.
- Based on the intensity, animals show nervousness, abnormal breathing, trembling or jerking muscles, the blue coloration of the lining of the mouth, spasms or convulsions and respiratory failure.

Treatment:

Animals which have not shown much evidence of toxicity may be injected intravenously with 3 grams of sodium and 15 gram sodium thiosulphate in 200 ml water for cattle. For sheep: 1 gram sodium nitrate and 2.5 gram sodium thiosulphate in 50 ml water.

Ruminants are more susceptible of HCl poisoning than are horses and pigs, because in the latter two species the enzyme concerned in the release of HCN is destroyed by the gastric HCl.

MYCOTOXINS

Mycotoxins are anti-nutritional substances which are secondary metabolites of fungi.

Especially *Aspergillus parasiticus* and *Aspergillus flavus* are known for production of specific toxin called "aflatoxin". Desirable conditions for growth of Mycotoxins are high temperature along with relative high humidity. In tropical and subtropical countries, aflatoxin can be better produced at 35C so temperature tolerance ability of fungi is responsible for aflatoxin production.

In the storage of corn grains; increased temperature and moisture contents invites the production of such toxin. If moisture contents are > 15% in the grains, then there are more

chances of aflatoxin production. Thus, you have to make efforts for reducing moisture contents. So, If moisture content are <12% moisture, then there will be no toxin production more profoundly.

Microbes when proliferate:

They utilize feed nutrients in terms of energy and proteins.

They reduce nutritive value of the feed (particularly protein contents “lysine”).

They also produce secondary metabolites called “toxins” ---- On ingestion impart negative effect on nutrient digestion and absorption. After absorption, these toxins negatively play with cell proteins, hepatic cells, and metabolism of primary nutrients.

Normally, broken corn grains are more subjected to toxin because corn naturally have a protected covering (*coat*) but once broken down then toxin/microbes will attach on it and results into; loss of its peculiar fragrance, it will lose its shine. Cracked shell further accelerate toxin production phenomenon.

Detection of Toxin:

To get a representative sample is quite difficult but physical parameters suggest toxin production as;

There would be an undesirable smell. When corn grains are subjected to microscopic study; there is presence of spores – that indicates corn may or may not contain toxin.

How Representative sampling is difficult? Because i) toxin may be present in isolated pocket and may not equally distributed ii) Toxins are present in a very small concentration (ppb,ppm) iii) Presence of spores do not conform the presence of toxin.

Toxin production depends on the different physiological stages; It may produce in transition period; while shifting sample to lab for analysis. You need to identify each toxin and its level individually.

Animal Response to toxin may differ depending upon;

i) *Health status of the animal:* Healthy animals are less susceptible than weak and diseased animals.

ii) *Age of the animals:* Young animals (b/c of under-develop rumen) are more prone compared to mature animals (rumen well-develop & microbes induce transformation in the toxin to its metabolites.)

iii) *Species difference:* Poultry birds are more susceptible than ruminants. Ruminants can tolerate relatively high concentration of toxin compared to poultry birds which are less tolerant.

iv) *Animal diet and Toxin level:*

Safe Concentration of Toxin:

A feed stuff having 0% concentration of toxin is ideal one. So in daily feeding practices, try to dilute the concentrations of toxin in the feed to minimize the –ve effects on animal.

- Toxin contaminated corn may have less energy value.
- In Soyabean meal, toxin production may deteriorate the amino-acid profile (particularly lysine).

Mix the contaminated feed ingredient with toxin free ingredient under the phenomenon of dilution.

For Example: If a poultry feed consists of 30% corn grains; then

Mix 5% toxin contaminated corn to 25% of toxin free corn. It will dilute the adverse properties of toxin, but do keep an eye over the total concentration of toxin in the diet.

Control Measures:

- 1st step to control toxin production phenomenon is proper storage. Proper storage will reduce it.
- Also add toxin binders in the diet. As they have such structures that can attach or combine or make complexes with toxins and ultimately these toxins are not allowed to interfere with nutrient digestion and absorption. Chelates with toxin from complex which is not normally hydrolysed, so animal remain safe from –ve energy level.

Other Effects:

- If there is increased concentration at gut level, they will interfere with enzyme activities and degradation of food. These toxins not only interfere with gut contents but also will attack on epithelial cell lines of gut and ultimately nutrient absorption will be hampered.
- The effects of toxins are –ve correlated with the physiology of circulatory system as well as of other vital organs. Once liver is damaged, then metabolism of primary nutrient is affected. Impaired performance of vital organs result into decreased animal performance. At post-mortem examination, liver exhibit pale color which is due to deposition of toxin and indicates death due to toxicity.

Concentration: *Poultry:* <100 ppb *Ruminants:* <300 ppb

Susceptibility of Animals to *Aflatoxin* differs because of following factors;

- i) Health ii) Age iii) Level of toxin iv) Nutrition or animal diet v) Exposure to toxin containing feed
- vi) Environment: Stressed environment make the animal more susceptible to be a victim of toxicity.

Visual Examination of Finished Feed

1. All finished fresh good feed has specific aroma. But toxin contaminated feed has off flavour/off aroma.
2. Caking/clumping formation and there is no natural flow in feed.
3. If you put hand in the feed, you will feel heat.
4. Darkening of color is an indication of presence of toxin.
5. When animal become off feed without any sign of disease and becomes lethargic to feed, then it is other indication of toxin in the feed.

Substances Inactivating or Increasing the requirements of certain vitamins.

1. Anti-vitamin A

It is present in the soybean meal. Raw soybeans contain an enzyme *Lipoxygenase* which catalyses oxidation of carotene, the precursor of vitamin A. It has been noted that 30 percent of ground, raw soybeans in the diet of dairy calves produced a sharp lowering of vitamin A and carotene in blood plasma. **Heat Treatment:** The enzyme can be denature/destroy by heating soyabeans for 15 min with steam at atmospheric pressure. But heat required for extraction of oil.

2. Anti-vitamin D

Rachitogenic activity of isolated soya protein has been found with chicks (poultry). The effects could be partially eliminated by increasing the vitamin D in the diet by 8-10 fold. Autoclaving eliminate this rachitogenic activity.

3. Anti-vitamin E

Animals fed on diets containing Raw kidney beans produce muscular dystrophy in lambs by reducing plasma vitamin E. Extra-provision of vitamin E may eliminate the problem of anti-vitamin sub. **Heat Treatment:** By autoclaving beans, the anti-vitamin activity is eliminated.

4. Anti-vitamin K

“sweet clover disease” is characterized by a fetal hemorrhagic condition in cattle and has been known for over 20 years. The active principle responsible for this disease is dicoumarol, which reduces the prothrombin level of the blood, thus interfering with the blood clotting mechanism. The effect is due to reducing vit. K utilization in the production of thrombin by the liver.

5. Anti-pyridoxine (Anti-vitamin B6)

It has been demonstrated in Linseed meal which was identified as 1-amino-D-proline, and occurs naturally in combination with glutamic acid as a peptide is known as linatine.

6. Mimosine

It is usually present in leguminous plants and constitutes 3-5 percent of the dry matter. The young leaves are relatively richer in mimosine content. In ruminants, mimosine is converted into 3,4 dihydroxypyridoxine (DHP) which is absorbed and come into circulation inhibit synthesis of thyroxine hormone.



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