DEPARTMENT OF ANIMAL NUTRITION

ANTI-NUTRITIONAL FACTORS IN LIVESTOCK FEEDSTUFFS

INTRODUCTION:-

- These are the substances that are present in diet which by themselves or their metabolic products arising in the system interfere with the feed utilization, reduce production or affects the health of the animal.

- These are often referred to as toxic factors.
- These are natural in origin.

CLASSIFICATION:-

A.According to chemical properties:-

Group-I	Proteins	1.Protease inhibitor 2.Haemagglutinins(lectins)
Group-II	Glycosides	1.Saponins 2.Cyanogens 3.Glucosinolates/Goitrogens
Group-III	Phenols	1.Gossipol 2.Tannins
Group-IV	Miscellaneous	1.Anti-metals 2.Anti-vitamins

GROUP-I:-PROTEINS

1.Protease inhibitors:-

- Prevent the proteolytic activity of certain digestive enzymes.
- 2 types of protease inhibitors are present,
  Kunitz inhibitor-Inhibits only trypsin
  Bowman-birk inhibitor-Inhibits both trypsin &Chymotrypsin

Source:- Legume seeds(Soybean,Kidney bean,mung bean)

Control:-

-Temperature, duration of heat, particle size & moisture level affect the destruction of trypsin inhibitor.

-The trypsin inhibitors extracted from SBM was destroyed by exposure to steam for 60 min or by autoclaving at 5 psi for 45min, 10 psi for 30min, 15 psi for 20 min duration.

2.Haemagglutinins(lectins):-

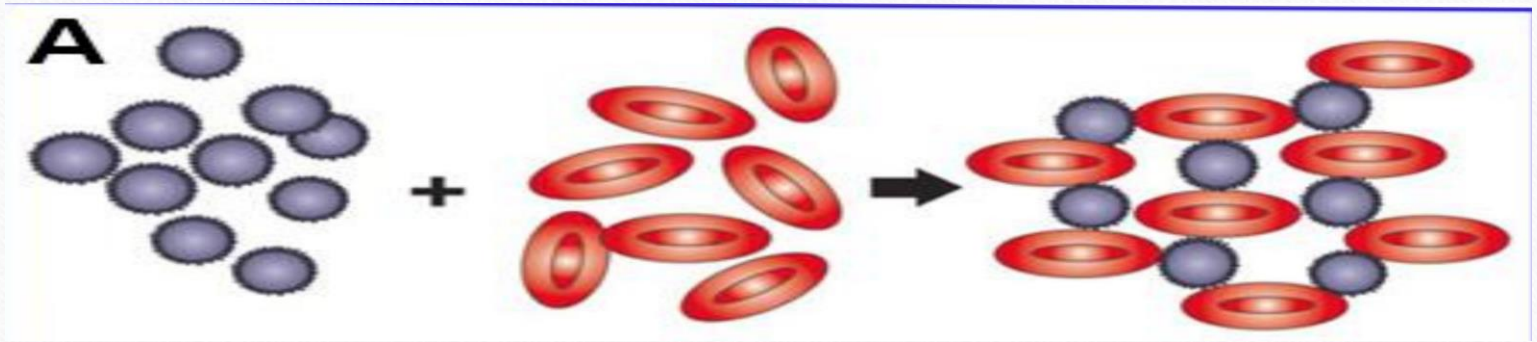
- These substances can bind to carbohydrate moieties of cell membrane.
- Lectins of soybean can bind to mannose of RBC & cause agglutination of RBC.

Source:-

- Soybean,castor bean (ricin)& other Legume seeds.

Control:-

-They are resistant to dry heat but can be destroyed by steam for 60 min.



GROUP-II:-GLYCOSIDES

- These are ethers that contain carbohydrate & a non- carbohydrate moiety combined with an ether bond.

1.Saponins:-

- Bitter taste,foaming nature & haemolyse RBC.
- They lower the surface tension in ruminants when they are taken in high amounts.

Source:-

- Soybean,lucerne
- 0.4-0.5% saponin in feed—decreases feed consumption in birds
- >5-7% lucerne meal in poultry mash—decreases weight gain & egg production
- When excessive green lucerne is fed,saponin toxicity occurs & it reduces surface tension of ruminal contents causing accumulation of gas.
- This condition is k/as Bloat /Tympany/ Tympanitis.

Control:-

- 1-2kg dry fodder should be fed before letting the animals for legume fodder.
- Turpentine oil & Paraffin oil are used to reduce bloat.

2.Cyanogens:-

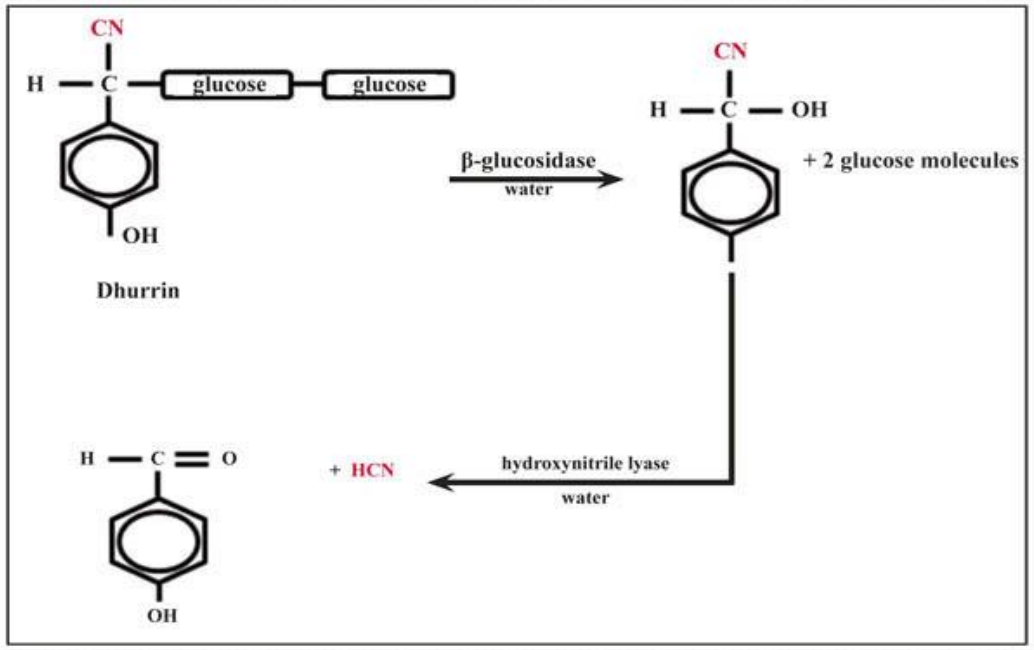
- Cyanogens are present in trace amounts in the form of cyanogenetic glycoside in plant Kingdom.
- These are hydrolysed to prussic acid/HCN by the enzyme such as β-glucosidase.
- HCN is rapidly absorbed & part of it is eliminated.
- The remaining part is detoxified in the liver to thiocyanate which affects the CNS by inactivating cytochrome oxidase & may lead to death.
- Ruminants are more susceptible than horses & pigs to HCN poisoning.

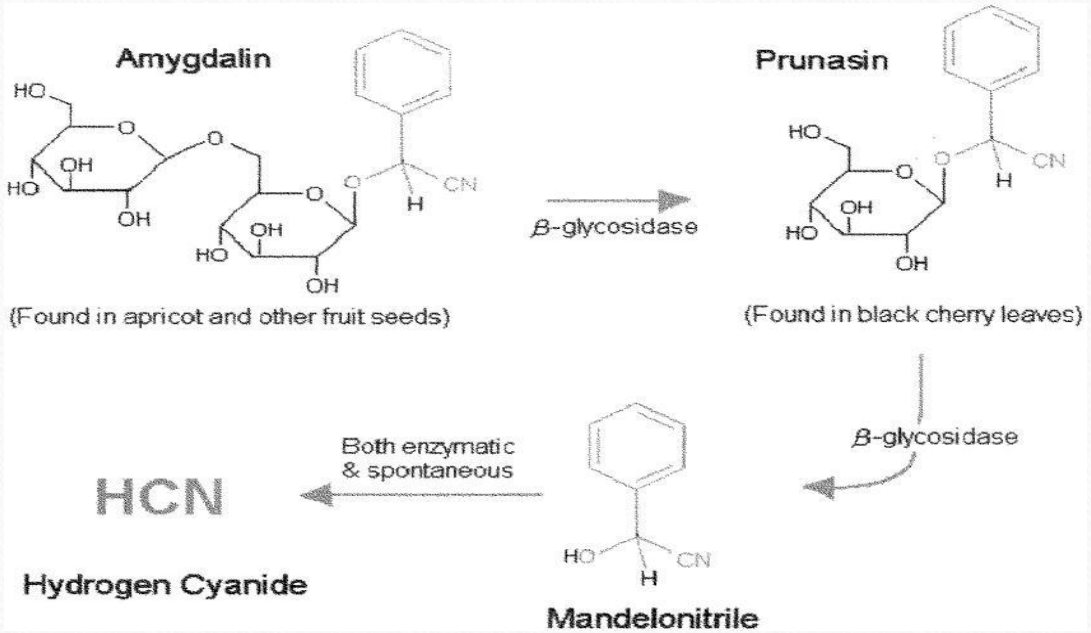
Source:-

S.no	Glycosides	Plant source
1	Amygdalin	Bitter almonds
2	Dhurrin	Sorghum vulgare
3	Linamarin/Phaseolunatin	Linseed,Cassava,Java beans

Control:-

- Avoid feeding immature jowar green fodder.
- 3g $NaNO_3$ + 15g $Na_2S_2O_3$ + 200ml water for cattle.
  1g $NaNO_3$ + 2.5g $Na_2S_2O_3$ + 50ml water for sheep.





3.Glucosinolates:-

- These depress the synthesis of thyroid harmone(T3,T4) causing Goitre.
- Glucosinolates occur in root, stem,leaf & seed & are always accompanied by the enzyme myrosinase(thioglucosidase).
- This enzyme hydrolyses glucosinolates → Thiocyanates
  → Glucose
  → Acid sulphate
  → Isothiocyanates
  → Nitriles

- Isothiocyanates —(Cyclization / Myrosinase)→ Vinyloxazolidinethione (Goitrogenic)

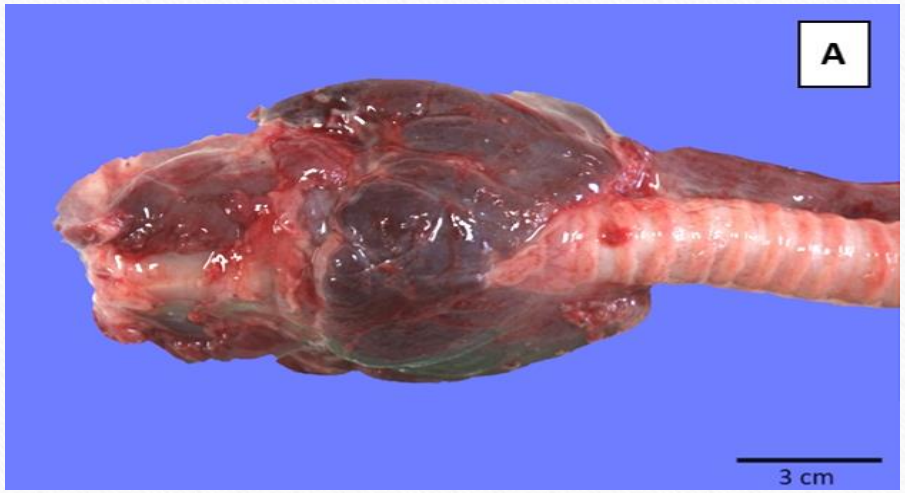
- Ruminants are comparitively less susceptible to this toxic effect compared to pigs & poultry.

Source:-

- Crucifera family (cabbage,turnips,rutabaga,rapeseed & mustard green)

Control:-

- Myrosinase is not only present in the plant/seed but also in the intestinal bacteria & helps in hydrolysis of glucosinolate.



GROUP-III:-PHENOLS

1.Gossypol:-

- This is highly toxic to monogastric animals.
- Ruminants are more resistant because gossypol forms stable complexes with soluble protein in rumen.
- Gossypol causes reduced appetite,loss of body weight,reduced Hb content.
- Egg yolk will have olive green colour in poultry.

Source:-

- Genus Gossypium have gossypol.

Control:-

-Toxic effect of gossypol can be overcome by supplementing iron as Ferrous Sulphate.

- Heat treatment decreases free gossypol & lysin from cotton seed meal.

2.Tannins:-

- These are polyphenolic substances with molecular weight greater than 500.
- Tannins are astringent in nature.

2 types:-Hydrolysable tannins:-gallotannins & ellagitannins

Condensed tannins:-These are flavonoids.

- They bind to the glycoproteins in the saliva & reduces it's lubricant action & hence these are inhibitors of proteolytic enzymes.
- High tannin content depresses cellulase activity & affects digestion of CF.
- Tannins control methanogeneis.

Source:-

S.no	Feed	Tannin content
1	Sorghum	2.0-10%
2	Salseed meal	9.0-12%
3	Mangoseed kernel	5.0-7%
4	Mustard oil cake	2.5-3.5%
5	Lucerne meal	0.1-3.0%

Control:-Detannification of feed stuffs.

1.Physical treatment:- Soaking & cooking decrease the tannin content.

2.chemical treatment:-Addition of tannin complexing agents like PEG(polyethylene glycol) & PVP (polyvinyl pyrrolidone).

- These prevent bond formation between tannin & protein.

GROUP-IV:-

1.Antimetals:-

(I) Phytic acid:-Also called inositol hexaphosphoric acid because it is an ester formed by combination of 6 alcoholic groups of inositol with 6 molecules of hexa phosphoric acid.

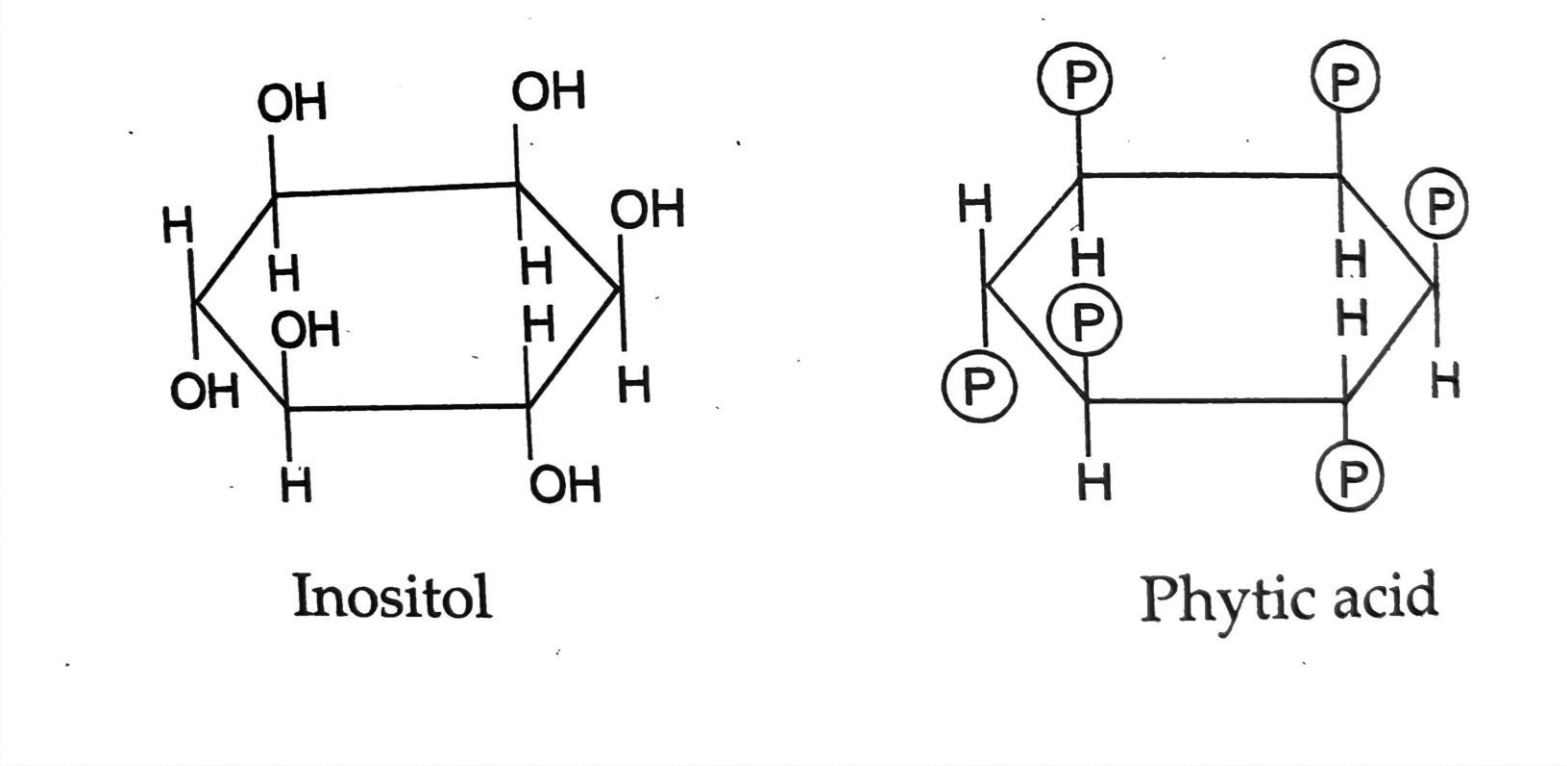
- Phytic acid depress the utilization of several mineral elements like ca,mg,fe,zn etc.,

Source:-

S.NO	Ingredient	Phytic acid (mg%)
1	Wheat	170-280
2	Maize	157-240
3	Rice	70-300
4	Soybean	402
5	Linseed	741
6	Cotton seed	366
7	Castor beans	500

Control:-

- Add enzyme phytase to ingredients of vegetable origin & it can increase phosphorous digestibility.



(II) Oxalic acid:-

- It is a dicarbocylic acid(COOH2)
- It is present in plant in the form of soluble oxalates i.e,K, Na & NH3 oxalates.
- Depress the growth & blood calcium.It causes depression, weakness,coma & death.
- When oxalic acid is high in diet,it combines with calcium to form insoluble calcium oxalates.

Source:-

-Paddy straw or other grasses like napier,bajra etc.,

-Different animals & Species respond differently to oxalic acid content.

2.Anti-vitamins:-

- These are organic compounds which either destroy vitamins or combine to form unabsorbable complexes or interfere with digestive/ metabolic functions.

a) Anti-vitamin A:-Lipoxygenase present in raw soyabean catalyses oxidation of carotene.

b) Anti-vitamin E:-Lipoxygenase present in kidney bean destroys vitamin E.

c) Anti-vitamin K:- Dicaumarol present in sweet clover is anti vitamin K.
It causes "sweet clover disease" which is fatal haemorrhagic condition.

d) Anti-vitamin D:-Isolated soya protein has rachitogenic activity.

e) Anti-pyridoxine:-1-amino-D-proline is an pyridoxine antagonist found in linseed.

f) Anti-Niacin:-Niacytin found in maize,wheat bran.
It causes perosis & growth depression.

g) Anti-thiamine:-Thiaminase enzyme present in bracken fern.

A.Perosis

B.Muscular dystrophy

C Rickets

B.On the basis of Nutrients they affect directly or Indirectly:-

1. Substances depressing digestion/metabolic utilization of proteins:-

- Protease inhibitors
- Haemagglutinin
- Saponins
- Polyphenolic components

2. Substances reducing solubility or interfering with the utilization of minerals:-

- Phytic acid
- Oxalic acid
- Glucosinolates
- Gossypol

3. Substances increasing the requirement of certain vitamins:-

- Anti-Vitamin A,D,E,K
- Anti- Vitamin B1,B6,B12 & nicotinic acid.

4. Substances with negative effect on the digestion of the carbohydrates:-

- Amylase inhibitors – Impairs digestion of starch
- Phenolic compounds
- Flatulence factors – Broken down in the large intestine by bacterial α-1,6-glactosidase.

Ref:-D.V.REDDY (2022) PRINCIPLES OF ANIMAL NUTRITION & FEED TECHNOLOGY 3rd edition
chapter 20:543-557(oxford & IBH Publishing Co.Pvt.Ltd.)