BIHAR ANIMAL SCIENCES UNIVERSITY, PATNA

Animal Nutrition

UNIT-1 : Principles of Animal Nutrition and Feed Technology

UG Lecture on

Feed Additives in the Rations of Livestock and Poultry

Dr. Kaushalendra Kumar

Assistant Professor, Bihar Veterinary College, BASU, Patna

Point to be discuss……..

- Feed additives
- Types of feed additives
- Antibiotics
- Probiotics
- Prebiotics
- Enzymes
- Hormones
- Organic acids
- Other growth stimulants etc.
- Advantages of feed additives
- Limitations of additives in livestock and poultry.

Feed Additives

- Feed additives are materials that are administered to the animal to enhance the effectiveness of nutrients and exert their effects in the gut or on the gut wall cells.

1. Antibiotics:

- Chemical compounds produced by other microorganisms (e.g. fungi, and are also synthesized in the laboratory) that, when given in small amounts, halt the growth of bacteria.
- They are used at therapeutic levels to treat diseases caused by bacteria.
- In subtherapeutic levels added to the feed/food to enhance the rate of growth.

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- **Various groups of antibiotics act in different ways to reduce the numbers of specific bacteria in the GIT, and increase the efficiency of nutrient utilization by;**

- **Reduction or elimination of the activity of pathogenic bacteria.**
- **Allowing the host to achieve production levels closer to their potential.**
- **Stimulation of growth of microbes that synthesizes unidentified nutrients.**
- **Reduction of the growth of microorganisms that compete with the host animal.**
- **Increased absorptive capacity of the small intestine by decrease thickness of intestinal wall.**

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- These effects may be coupled with a reduced turnover of mucosal cells as well as reduced mucous secretion.
- Large proportion of the energy & protein required to maintain an animals &
- Any reduction in the mass of the gut & cell turnover will release nutrients for other purposes such as growth & production.
- AGPs used mainly in pig & poultry feeds @20–40 mg/kg
- Improvements of 4–16 percent in growth rate & 2–7 percent FCR.
- Response is greatest in young animals & consuming diets containing vegetable protein rather than animal protein.
- Effect is less in healthy herds and flocks.
- Young pre-ruminant calves also respond to AGPs in the same manner as non-ruminants.

Modes of action of antibiotics

- **Antibiotics halt the growth of bacteria by interfering with their cellular metabolism. There are four groups;**

i. Interfere with the synthesis of bacterial cell wall & cause the cell to burst:

- ✓ **These are high-molecular-weight (>1200) compounds that act on Gram positive bacteria.**
- ✓ **They are poorly absorbed by the host and thus are non-toxic**
- ✓ **Leave no detectable residues and have no withdrawal period (i.e. a period of time during which the compound must be removed from the food/body before the animal is slaughtered).**
- ✓ **Examples of this type of antibiotics are Avoparcin & Flavomycin.**

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ii. Inhibitors of bacterial protein synthesis:

- ✓ **Primarily active against Gram-positive bacteria & have a medium MW (>500).**
- ✓ **Absorbed to a greater extent than the higher-molecular-weight compounds, they do not have a withdrawal period.**
- ✓ **Examples- Tylosin & Virginiamycin.**

iii. Inhibitors of bacterial DNA synthesis:

- ✓ **These can have a broad spectrum of activity, have a low MW (about 250) & require withdrawal periods.**
- ✓ **Examples- Nitrofurans & Quinoxaline-*N*-oxides.**

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iv. Ionophore antibiotics:

- ✓ Interfere with the electrolyte balance (Na/K) of bacterial cell by transporting potassium into the cell, which then requires energy to pump it out.
- ✓ Ion pump fails to operate efficiently & potassium accumulates inside the cell.
- ✓ Water enters by osmosis & the cell becomes rupture.
- ✓ Example- Monensin sodium

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- Ruminants depend primarily on rumen microbes for their nutrient supply & use of antibiotics might be disadvantageous.
- However, certain AGP of ionophore type (e.g. monensin sodium) found effective with low-roughage : high-concentrate diets.
- Reduced methane production & increased propionic acid proportions, which improve productivity.
- Monensin sodium @20–30 mg/kg feed, improves the feed efficiency.
- Amino acid degradation is decreased & spare amino acid may use for gluconeogenesis & enhanced propionic acid production.
- Recently, due to development of antibiotic resistance, AGPs has been curtailed by several countries.

2. Probiotics

- Probiotic is defined as a live microbial food supplement that beneficially affects the host animal by improving the intestinal microbial balance.
- Beneficial microbes produce enzymes that complement the digestive ability of the host & their presence provides a barrier against invading pathogens.

Desirable bacteria exert their effects in different ways;

✓ **Adhesion to the digestive tract wall to prevent colonisation by pathogenic microorganisms:**

➢ **E. coli, need to become attached to the gut wall to exert their harmful effects.**

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- Attachment is achieved by means of hair like structures on the bacterial surface, called fimbriae.
- Fimbriae are made up of proteins k/a lectins, which recognize & selectively combine with specific oligosaccharide receptor sites on the gut wall.
- Lactobacilli successfully compete for these attachment sites.

✓Neutralization of enterotoxins produced by pathogenic bacteria that cause fluid loss:

- Live probiotic bacteria can neutralize toxins, but the active substance has not been identified.

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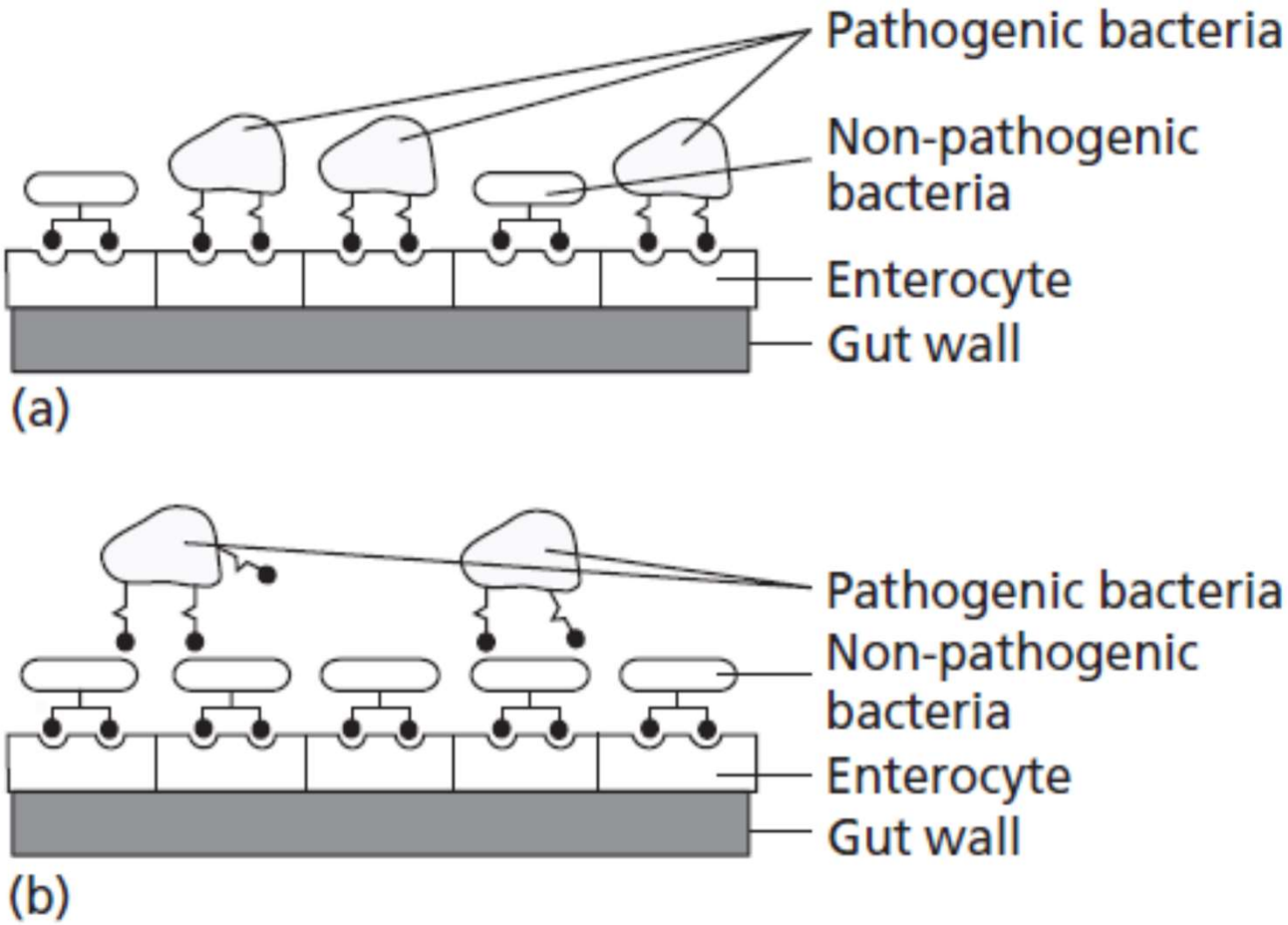
Pathogenic bacteria
Non-pathogenic bacteria
Enterocyte
Gut wall
(a)
Pathogenic bacteria
Non-pathogenic bacteria
Enterocyte
Gut wall
(b)

Cont.....

- ✓ **Bactericidal activity:**
- ➢ **Lactobacilli ferment lactose to lactic acid, thereby reducing the pH to a level that harmful bacteria cannot tolerate.**
- ➢ **Hydrogen peroxide is also produced, which inhibits the growth of Gram-negative bacteria.**
- ➢ **Lactic acid producing bacteria of the Streptococcus and Lactobacillus species may produce antibiotics.**
- ✓ **Prevention of amine synthesis:**
- ➢ **Coliform bacteria, decarboxylate amino acids to produce amines, cause gut irritation, leads to diarrhoea.**
- ➢ **If desirable bacteria prevent the coliforms proliferating, then amine production will also be prevented.**

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- ✓ **Enhanced immune competence:**
- ➢ **Oral inoculation of Lactobacilli can elevated serum protein & WBC.**
- ➢ **Aids immune system development by stimulation of the production of antibodies and increased phagocytic activity.**
- ✓ **Other postulated effects include:**
- ➢ **Beneficial interaction with bile salts,**
- ➢ **Increased digestive enzyme production,**
- ➢ **More efficient absorption of nutrients &**
- ➢ **Greater vitamin production**

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- In monogastric, strains of Lactobacilli, Bacillus subtilis & Streptococci have been used as probiotics.
- In ruminant, yeast (*Saccharomyces cerevisiae*) in the form of live culture, or dead cells with culture extracts, has proved successful.
- Metabolites of dead & live yeast cells (B vitamins, BCFA, amino acids & peptides) stimulate the growth of the bacterial species *Megasphaera elsdenii.*
- This utilizes the lactic acid produced from the rapid fermentation of starch & sugars associated with high-concentrate diets.
- Also live yeasts ferment sugars derived from the degradation of starch, thus competing with the lactic-acid-producing bacteria & thereby stabilize rumen pH & reduce the risk of acidosis.

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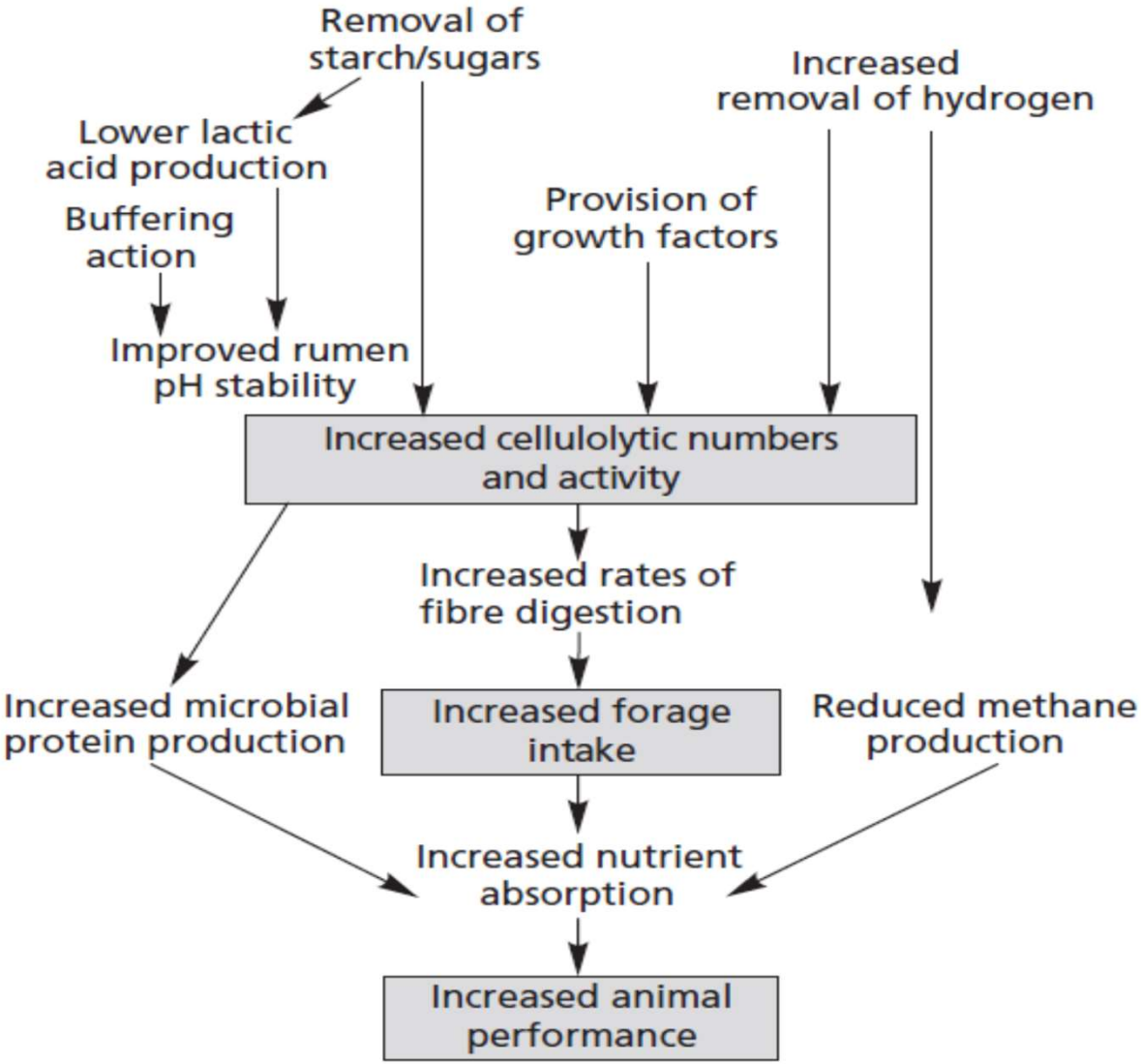
Removal of starch/sugars
Increased removal of hydrogen
Lower lactic acid production
Buffering action
Provision of growth factors
Improved rumen pH stability
Increased cellulolytic numbers and activity
Increased rates of fibre digestion
Increased microbial protein production
Increased forage intake
Reduced methane production
Increased nutrient absorption
Increased animal performance

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- Live yeast cultures also scavenge oxygen in the rumen, helps to maintain anaerobic conditions & favouring the growth of cellulolytic bacteria.
- Increase forage intake, result in improved liveweight gain, milk yield & milk fat content.
- Addition of yeast to intensive beef diets has increased daily live weight gain and food conversion efficiency.
- Improved fibre digestion has also been reported in horses when yeast cultures have been given.

3. Prebiotics:

- ✓ Defined as compounds other than dietary nutrients that modify the balance of the microflora population by promoting the growth of beneficial bacteria & thereby provide a healthier intestinal environment.

Oligosaccharides occur naturally in foods such as;

- ✓ Soya bean meal, rapeseed meal & legumes contain alfa-galactooligosaccharides (GOS);
- ✓ Cereals contain fructo-oligosaccharides (FOS);
- ✓ Milk products have trans-galactooligosaccharides (TOS);
- ✓ Yeast cell walls contain mannan-oligosaccharides (MOS).
- ✓ They are also produced commercially.

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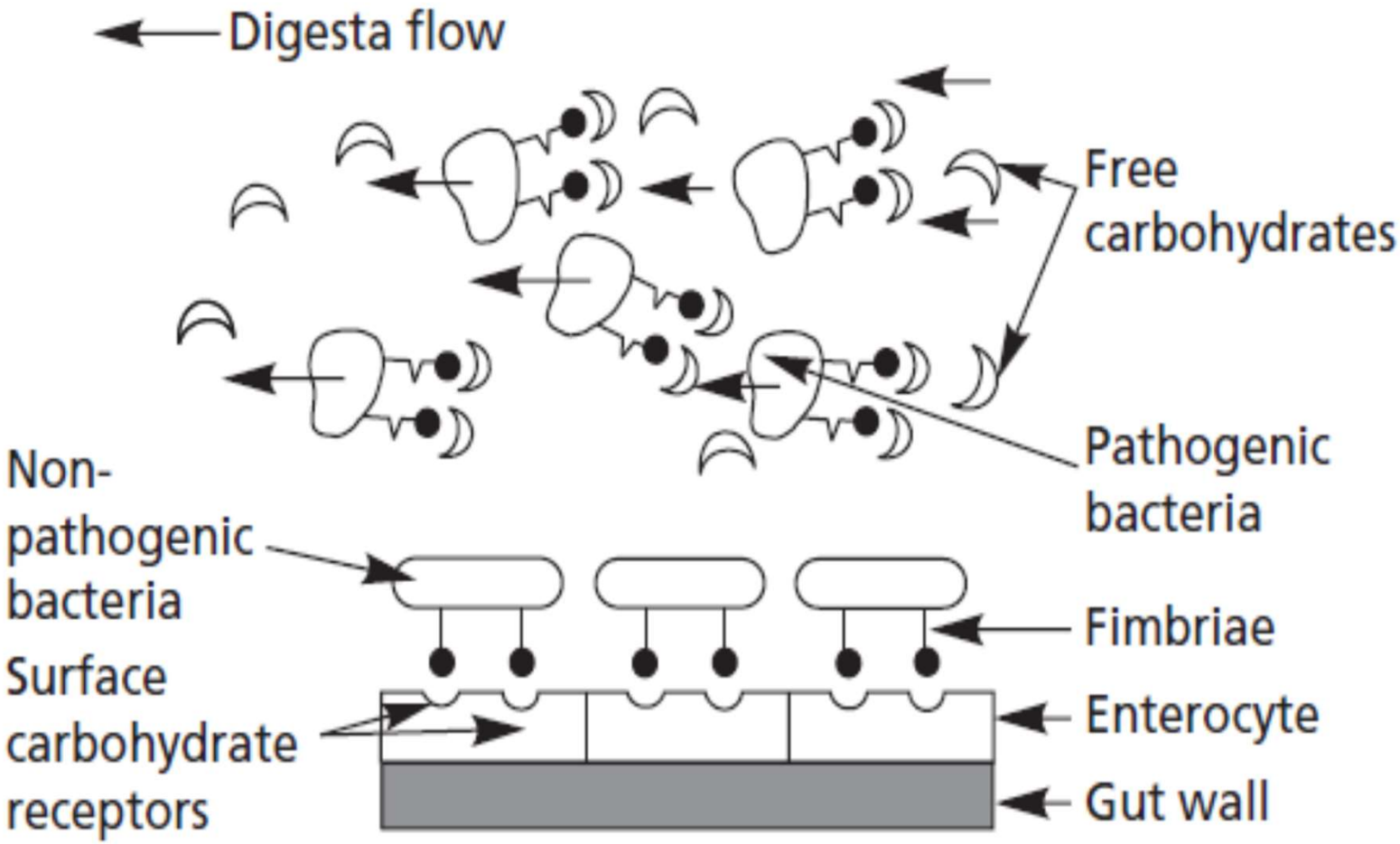
Digesta flow
Free carbohydrates
Pathogenic bacteria
Non-pathogenic bacteria
Fimbriae
Surface carbohydrate receptors
Enterocyte
Gut wall

- Pathogenic bacterial cells have surface compounds called lectins that recognise these carbohydrates & by which they attach to the gut cells.
- Lectin–carbohydrate combination is specific to a particular organism.
- Salmonella & E. coli have a mannose-specific lectin that binds to mannose residues on the gut mucosal surface.
- However, if the same carbohydrate (oligosaccharide) is provided in the diet, harmful bacteria can be encouraged to attach to these &
- They do not adhere to the gut wall but are excreted without producing toxins.

4. Arsenicals:

- Arsenic compounds, namely arsanilic acid, sodium arsanilate & 3 -nitro-hydroxyphenyl arsenic acid are also used as growth inhibitors for pathogenic organism & to restore conditions of recovering animals.
- The amount of arsenic retained in the tissues is very low.
- It is desirable to discontinue arsenicals from the diet at least 5 days before slaughter.
- Arsenicals recommended to add @ 50-70 g/tone of feed.

5. Buffering Compound:

- Buffers are mixtures of weak acids and their conjugate bases.
- A more appropriate term is neutralizing or alkalinizing agents.
- When present in aqueous solution, buffers should resist changes in pH upon addition of acid or base.

- Buffer modify ruminal fermentation by;

✓ Increasing or resisting change in ruminal pH & increasing fractional outflow rate through the reticulo-omasal orifice (ruminal fluid dilution rate).

✓ The increase in fluid dilution rate is due to increased osmolarity which increases both water intake & influx through the ruminal wall.

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- NaHCo3 & MgO are used routinely in dairy cattle, to counteract the depression in milk fat synthesis due to low ruminal pH & reduced acetate/propionate ratio induced by a low roughage & high grain diet.
- Supplements of NaHCo3 should be 0.6 to 0.8 percent of a total mixed diet & 1.2 to 1.6 percent of a concentrate mixture.
- MgO should be added @ 0.2 to 0.4 per cent of total mixed diet or 0.4 to 0.6 percent of a concentrate mixture.
- When feeding a combination of two, 2 to 3 parts NaHCO3 should be mixed with one part MgO.
- Feeding large amounts of these mineral salts may depress feed intake.

6. Antioxidants:

- Antioxidants are chemical compounds which have the capacity of preventing oxidation of substance by taking up oxygen.
- High fat vegetable products (oils/fat), tallow, lard, fish meal & poultry by product meal are more prone to oxidative rancidity.
- Cause off-flavours which reduces voluntary feed intake & bioavailability of amino acids & fat soluble vitamins like vitamin A & vitamin E.
- Ex- butylated hydroxyl anisole (BHA), butylated hydroxy toluene (BHT) & ethoxyquin & natural antioxidants include vitamin E, vitamin C & rosemary.
- Added to feed ingredients & vit. premix @125 to 200g/tonne of feed.
- Synthetic antioxidants are comparatively cheaper and long lasting.

7. Enzymes:

- **Fibrolytic enzymes such as cellulase, Phytase, xylanase & beta-glucanase increase nutrient utilization efficiency, eliminate toxic effects of feed in non-ruminant.**
- **In ruminants, rumen microbes produce sufficient quantity of these enzymes.**
- **Exogenous polysaccharide degrading enzymes are stable in the rumen & may pass to lower tract, hence can improve nutrient utilization by animals.**
- **It is apparent that enzymes substantially improve feed digestibility and animal performance.**

8. Hormones:

- Hormones are substances produced by endocrine glands that activate specifically the target organs to produce the desired result.
- Synthesized compounds also have similar response as naturally produced hormones & can be used as feed additive to promote animal growth.
- They are used to bring desirable changes in rate of metabolism for efficient productivity.
- They can be grouped into anabolic and catabolic hormones.

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- Anabolics are growth hormone & thyroxine, used for increasing animal productivity either through growth or egg or milk production.

✓ Ex- Bovine somatotropin – for increasing milk production

Iodinated casein – for increase egg production

- Catabolics are estrogen & glucocorticoids, increase muscle & bone formation at the expense of fat deposition.
- But the use of hormones has much public concern due to the residue present in animal products.
- Several countries banned the use of these hormonal preparations.

9. Adsorbents:

- Compounds that are not absorbed from the GIT & have the ability to bind physically with toxic substances thus preventing their absorption.
- The use of adsorbents such as activated charcoal & silicates are commonly used in livestock exposed to dietary aflatoxins.
- Activated charcoal administered @ 20-120 mg/kg to domestic animals.
- Several substances like alumino-silicates, bentonite, silicon, zeolites etc. found beneficial in minimizing the toxic effects of mycotoxins.

10. Organic acids:

- Some organic acids specially malic acid & fumaric acid are potent rumen manipulation agent.
- Malate stimulates lactate utilization by *Selenomonas ruminantium*.
- Malate was more effective in lactate utilization than fumarate or aspartate
- Forages rich in malate (Lucerne, Bermuda grass) may be used for rumen manipulation.
- Fumarate was also found to be beneficial for fibre rich diets.
- Other ex- citrate, formic acid etc.

11. Flavoring agent & Pigments:

- Flavoring agents are used to enhance the palatability of feeds especially, fish meal & other vegetable protein meals in the diet of (flavor sensitive) pet animals.
- Pigmentation compounds are used to satisfy consumer preference.
- Xanthophylls present in yellow maize and Lucerne meal are used to produce deep yellow pigmentation in body & egg yolk.

Discussions……..

Questions, if any……??

THANKS