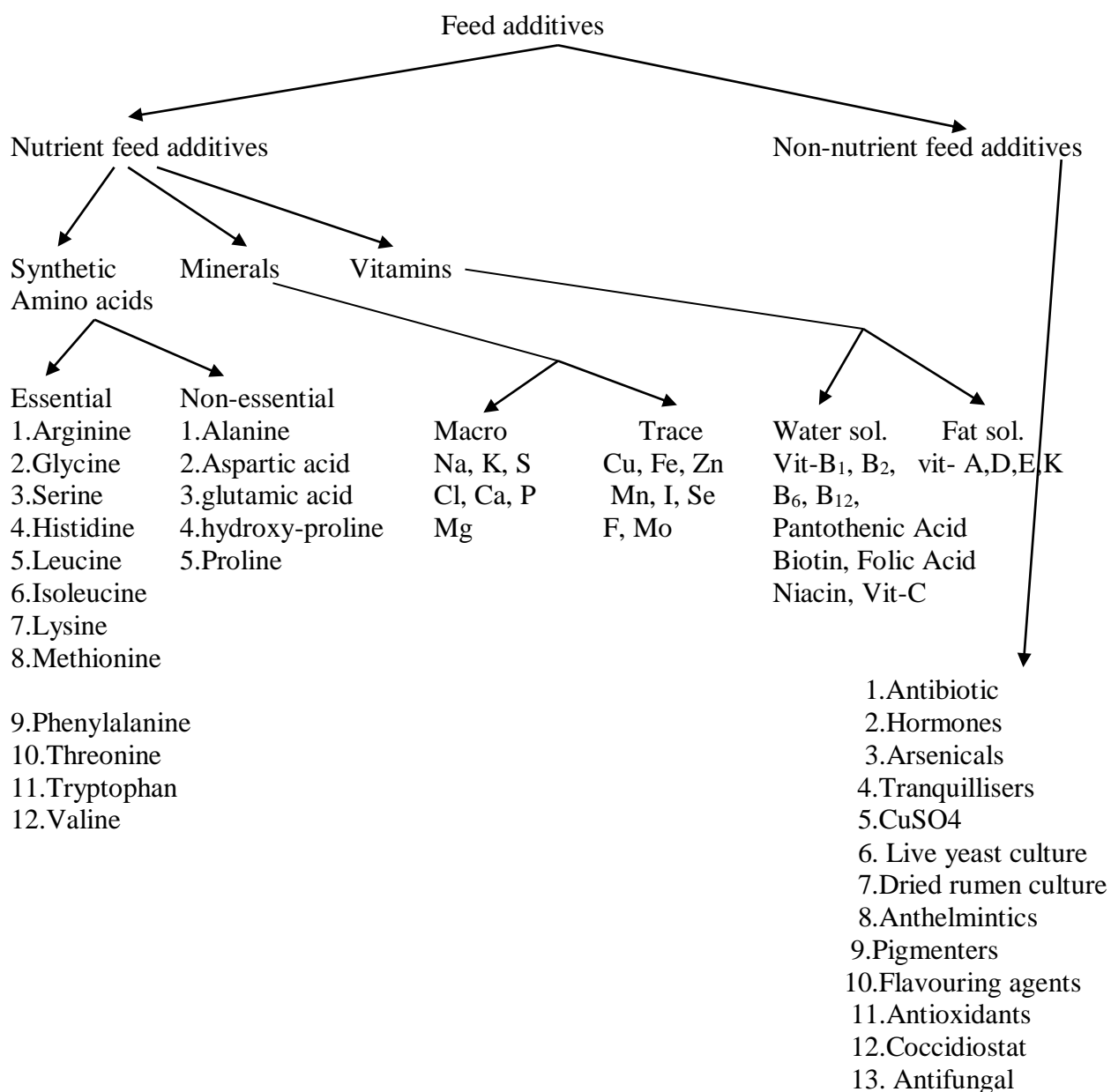


Feed Additives

Feed additive is an ingredient or combination of ingredients mixed together to provide nutrients in the diet at levels required by the livestock to fulfil the specific need. Usually they are used in micro quantities for the purpose of improving rate of gain, feed efficiency, or preventing and controlling disease.

Feed additives are broadly classified into nutrient feed additives and non-nutrient feed additives.



Types of feed additives:

- I. Additives that influence feed stability, feed manufacturing and properties of feeds.
 - A. Antifungal
 - B. Antioxidants
 - C. Pellet binders
- II. Additive that modify animal growth, feed efficiency, metabolism and performance.
 - A. Feed flavour
 - B. Digestion modifiers: 1. Enzymes 2. Buffers 3. Ion-exchange compounds 4. Ionophores and methane inhibitors 5. Isoacids 6. Probiotics 7. Acidifiers (Organic acids) 8. Antibloating agents 9. Salivation inducers 11. Defaunating agents
 - C. Metabolism modifiers: 1. Hormones 2. Beta adrenergic agents (repartitioning agents)
 - D. Growth promotants: 1. Antibiotics 2. Chemotherapeutic agents 3. Saponins
- III. Additives that modify animal health
 - A. Drugs
 - B. Environmentally active substances
 - C. Immuno modulators
- IV. Additives that modify consumer acceptance
 - A. Xanthophylls
 - B. Saponins

Advantages of use of feed additives:

1. Improve colour, increase feed quality and feed palatability
2. Improve animal performance by promoting animal growth, feed consumption, protecting the animal against all sorts of harmful environmental influences.
3. Improve the final product and increase shelf life by the addition of mycotoxin inhibitors, pellet binders, sweeteners, antioxidant and preservative etc.
4. Economise the cost of animal production as dietary supplementation of antibiotics and other additives lowers the cost of meat, milk and egg production.

Disadvantages of feed additives:

1. Residues of antibiotics or hormones in meat, milk and eggs have serious consequences for disease control in humans or domestic animals.
2. May cause allergy.

Non-nutrient feed additives

1. **Antibiotic feed additive**: antibiotics are a group of soluble organic substances produced from microorganism, which in small concentration have the capacity of inhibiting the growth of other microorganism, and even of destroying them.

Antibiotic feed additive is of two types:

- A. **Ionophore Antibiotics:**-These antibiotics facilitate the transport of ions (such as Na⁺, K⁺, Ca²⁺) across biological membranes, disrupting ion gradients and membrane potential.

Mechanism:

- Bind to specific ions and transport them across the microbial membrane.
- Disrupt ion homeostasis, leading to cell death.

Examples:

- **Monensin** (used in veterinary medicine)
- **Valinomycin**
- **Lasalocid**

Uses:

- Primarily used as **antibacterials, antifungals, and antiparasitics**.

Common in livestock feed to prevent bacterial infections and promote growth.

- B. **Non-Ionophore Antibiotics:**-These antibiotics do not transport ions across membranes but instead act through different mechanisms such as inhibiting protein synthesis, cell wall synthesis, or DNA replication.

Mechanism:

- Target bacterial ribosomes, cell walls, or enzymes essential for survival.
- Do not disrupt ion transport directly.

Examples:

- **Penicillins** (inhibit bacterial cell wall synthesis)
- **Tetracyclines** (block bacterial protein synthesis)
- **Fluoroquinolones** (inhibit bacterial DNA replication)

Uses:

- Broadly used to treat bacterial infections in **humans and animals**.

Mode of action:

1. Some antibiotic have a sparing effect on vitamin B as found in Rats and chickens.
2. The antibiotics act by increasing the absorption of B-complex vitamin in gastro-intestinal tract.
3. Antibiotics increase the absorption capacity of the intestine.
4. The drugs affect various enzyme systems eg. Some oxidative phosphorylation reactions.
5. It causes the stimulation of microorganism in the GI tract which favours nutrient synthesis eg. Vitamins, amino acids.
6. Reduce the growth of microorganism that compete with the host for nutrients
7. Suppress or destroying organism which produced sub-clinical infections.
8. They inhibit the growth of bacteria which produce toxins that reduced the growth of animals.
9. Antibiotics decrease the vitamin D requirements for normal bone calcification and lower Mn requirements for growth and prevention of perosis.
10. Stimulate the growth of micro-organism that synthesise known or unidentified nutrients.
11. Antibiotic alter intestinal bacteria so that less urease is produced and thus less NH₃ is formed.
12. Reduce the incidence of liver abscesses in beef cattle fed high grain rations.

13. Both the ionophore and non-ionophore antibiotics have been used in non-ruminants and preruminants, while only the ionophores have been successfully used in adult ruminants.

Antibiotics in pig feeding:

- The good effect of feeding the antibiotics feed supplement is observed with animals given all vegetable protein diets than those receiving animal protein supplements.
- The growth response in pigs is variable according to the degree of hygiene under which the pigs are reared.
- The increase in growth rate may vary between 10-20% percent and reducing the feed intake by about 2.5%.
- The antibiotic improves the efficiency of feed utilization to the extent of 5-8 percent.

Antibiotics in poultry feeding:

- Penicillin is more effective than other antibiotics especially to young and growing chicks.
- It increases the growth rate and this effect is most marked upto one month of age.
- The highest effect is upto 6 weeks of age. In the laying birds the egg production is also improved.
- Use of a combination of antibiotics has been no more effective than that of a single effective antibiotic.
- In layer, egg production has not been increased by adding antibiotics to a ration which is nutritionally complete.

Antibiotics in ruminant feeding:

- The addition of antibiotics supplement in calf ratio has increased the growth rate of dairy calves especially when there has been much trouble from disease in the herd.
- It has reduced the incidence of scours and other infectious disease.
- Most of the growth improvement occurs before the calves are 8-10 weeks of old.
- Following points should be kept in mind while using antibiotics for animal feeding:
 - ❖ Antibiotics should be used only for:
 - ✓ Growing and fattening pigs
 - ✓ Growing chicks and turkey
 - ✓ Growing calves up to the age of 10-12 weeks
 - ❖ Antibiotics should not be used in the feed of ruminant animals (cattle, sheep and goat), breeding pigs and breeding and laying poultry stock.
 - ❖ While adding antibiotics at the recommended level, care should be taken that they are thoroughly and evenly mixed with the feed.
 - ❖ For the best result, antibiotics should be used with properly balanced feeds.
 - ❖ Antibiotics are not a substitute for good management and healthy living condition or for properly balanced ration.
- Antibiotic feeding hazards in animals:

- There has been a serious concern about the indiscriminate use of antibiotics as feed supplement in animals.
 - The meat from these animals contains the residue of the antibiotics and constant use by the human being could present a hazard to human health because of the potential development of enteric bacteria.
 - The use of antibiotic feed supplements or the fortified ration or the medicated feeds is governed by strict state laws in some countries (USA, Canada and UK) where they are used for livestock and poultry so that farmers will not run unnecessary risk in using them.
2. **Hormones:** the active principles secreted by the endocrine glands into the blood for transportation to target organs and tissues are known as hormones. Some of the hormones used as growth promoting agents in livestock such as estrogen, androgens, progesterone, growth hormones, thyroxine and thyroproteins.
- The growth promoting hormones are grouped into two on the basis of their effects in the body.
1. Anabolic (Somatotrophin, thyroxine and androgens)
 2. Catabolic (Estrogen and glucocorticoids)

Anabolic agent: the hormones of the anabolic class by nature exert their effect on both skeleton and protein metabolism. Somatotropin stimulates growth of endochondral bones and epiphysis of long bones while in protein metabolism it aids nitrogen retention and overall protein synthesis. Thyroxine also stimulates growth of long bones as well as protein synthesis. Testosterone at low dose increases the epiphyseal diameter, promotes muscle growth by augmenting nitrogen retention.

Catabolic agents: similarly exert their effect on both skeleton and protein metabolism. Estrogen inhibits skeletal growth although in ruminants it increases nitrogen retention. Glucocorticoids decrease growth of epiphysis and also aid in degrading protein and amino acids and thereby inhibit protein synthesis in extrahepatic tissues. Some oestrogenic activity is present in some clovers, sesbania etc. These are exogenous sources of hormones. These are administered orally as feed additives, S/C implants or parenteral injections.

Effect of hormones on milk production:

- It is an established fact that milk production in the cow will increase following the feeding of thyroprotein or thyroxine.
- The addition of hormones in the diet of cows has increased milk production from 15 to 20% above control animals, if concomitant increase in energy intake was maintained.

Harmful effects of hormone feeding:-

- Restlessness, milk secretion from rudimentary teats
- Residues of synthetic oestrogen in the meat which have carcinogenic properties.
- Feeding of thyroprotein in dairy animals causes general excitability and injuries in the body.

Other synthetic hormones:

Zeranol, TBA (Trenbolone aceate), Synovex plus, bovine somatotropins (BST), Equine somatotropin (EST) etc.

3. **Probiotics:-** The term probiotic means 'for life'. Probiotics, also known as pro-nutrients and direct fed microbials, are **live cultures of non-pathogenic viable organisms** which are administered orally. Probiotics are live microbial feed supplements which beneficially affect the host animal by improving its intestinal microbial balance. Probiotics are available in pastes, powder and liquid form or directly fed feed additives. Most commonly used microorganisms, as probiotics are *Lactobacillus acidophillus*, *Lactobacillus fermentum*, *Lactobacillus lactis*, *Aspergillus oryzae*, *Streptococcus foecium*, *Saccharomyces cerevisiae* etc. Live yeast culture, Direct fed microbials (DFM) and curds are examples of probiotics.

Mode of action may be competitive with the harmful enteric microorganism, stimulatory for increasing growth rate and thus the productivity and nutrient sparing or the combined effects.

Yeast culture: Hungate (1966) observed that rumen bacterial concentrations increased when fermentation products such as yeast cultures were added to the diet. By products of fermentation include dried brewer's yeast, dried distillers soluble, dried bacterial press cakes.

Direct fed microbilas (DFM): DFM are a type of probiotic additive, usually composed of living or biologically active spore forming microorganisms. There are bacteria and yeast can replace antibiotics in livestock and poultry feed.

DMF include *Lactobacillus*, *Streptococcus*, *Bacillus* and Yeast (*Saccharomyces cerevisiae*).

4. **Feed enzyme additives:** feed enzyme additives act as biocatalysts to assist the digestion process and support utilization of nutrients that otherwise go unused. Cellulolytic or hemicellolytic enzymes are beta glucanase, xylanase, mannase, pectinase, beta galactosidase, 1-4 beta galactanase. A multienzyme preparation with cellulolytic and proteolytic activity can degrade the structural polysaccharide and protein. Eg. Cellulose and protease. Fibrozyme is the first feed grade enzyme that is rumen stable and increase dry matter digestibility, VFA production and CHO utilization in cows fed diets containing high amounts of fibre.

5. **Antioxidants:** lipid peroxidation or auto oxidation of feed fats causes rancidity spoiling the taste and flavour of the feed oxidation also causes much loss to carotenes, vit-A and Vit-D. The use of antioxidants limits this oxidative spoilage. Antioxidants are natural and synthetic. Natural ones are vit-E (tocopherol) and ascorbic acid. Synthetic antioxidants are ethoxyquin, BHA (Butylated hydroxyl anisole) and BHT (Butylated hydroxyl toluene).

6. **Prebiotics:** - Prebiotics are non-digestible carbohydrate that beneficially affect the host by selectively stimulating the growth and or activity of one or limited number of bacteria in the colon that can improve the host health. Galacto oligosaccharides, fructo oligosaccharides and lactose derivatives have been used in poultry and other non-ruminants. Oligosaccharides may

directly inhibit the growth of certain intestinal pathogenic species by increasing the concentration of lactic acid which will decrease the pH in the lower gut. Microbes are able to attach themselves to the mucosa through recognition of oligosaccharide binding sites on the wall. Dietary oligosaccharides attract microbes away from the intestinal binding sites and therefore, reducing colonization of pathogens. More over, certain oligosaccharides like α -1,2-glucosyl oligosaccharides substrate for beneficial *Bifidobacterium sp.* at lower tract which favoured their colonization and prevent colonization of harmful bacteria.

MOS : (Mannan oligosaccharides) it is a complex carbohydrate extracted from yeast cell wall, improves the health and performance of monogastric animals. It blocks the attachment of pathogenic bacteria to the animals intestine and prevents colonisation that can result in disease.

FOS: (Fructo oligosaccharides) feeding FOS helps proliferation of beneficial bacteria such as *Lactobacillus spp.*, *Bifidobacterium spp.* And *Bacteroides spp.* Which inhibit growth of more harmful bacteria and reduction of flatulence in animals.

7. **Arsenicals:** organic arsenicals have growth promoting properties similar to those of antibiotics when added to the diet of chicks. In addition to their use as growth stimulants, these have been used at low levels to help protect feeds from microbial destruction and to prevent and control poultry diseases. Arsanilic acid, sodium arsanilate are compounds used.

8. **Tranquillizers:** A number of tranquilizing drugs have been usually used to combat stress due to heat or other environmental factors. Certain tranquilizers such as natural alkaloid of *Rauwolfia*, reserpine, hydroxyzine, chlorpromazine have been shown in certain trails to improve daily live weight gain to livestock. The compounds act by reducing hypertension and nervousness specially in summer or under any stress condition.

9. **Copper sulphate:** At 0.1 percent level of the diet in fattening pigs, improve the rate of gain and feed conversion efficiency between weaning and bacon weight. Sheep are particularly susceptible to copper poisoning, and there are several instances of death through sheep eating copper fortified pigmeals.

10. **Anthelmintics, coccidiostat and antifungal:** Anthelmintics are the deworming drugs and used periodically in the feed or water to prevent parasitic infestation, specially of round worm. Out of many commercial products, 2,2 dichlorovinyl dimethyl phosphate, has both anthelmintics and separate growth stimulatory effect in cattle. Coccidiostat are routinely used in the diets of the poultry to prevent the most devastating type of disease the coccidiosis. Antifungals are natural or synthetic substances which inhibit the growth of fungi. Example: Calcium propionate or sodium propionate.

11. **Pigmenters and flavoring agents:** Pigmenters are usually carotenoid sources added to feed to improve pigmentation of broilers and egg yolk. Some time some flavouring substances such as

non volatile substances eg. Esters, alcohols, terpenes etc. are also used as feed additives to improve the palatability of certain feed stuffs.

12. **Mycotoxin binders:** activated charcoal, yeast cell wall products, synthetic zeolites and mined mineral clays such as aluminosilicates, sodium bentonite etc. Are the common mycotoxin binders which are used in feeds. Mycotoxin producing fungi are *Aspergillus*, *Fusarium* and *Penicillium* and toxins are aflatoxins, zearalenone, trichothecenes, fumonisins, ochratoxin A etc.

13. **Pellet binders:** calcium lignosulphonate, sodium lignosulphonate are byproduct from wood pulp manufacture. These are widely used as pellet binders in animal feed.

14. **Methane inhibitors:** feeding of poor quality roughage in ruminants results in more methane production during their enteric fermentation, leading to wastage of dietary energy. Sustainable animal production system requires that methane production should be less per unit output. So several methane inhibitors like methane analogues, 2-bromomethane sulphonic acid, probiotic, monensin, defaunation of animals, fatty acids and related compounds, particularly unsaturated fatty acids are also used to inhibit the methane production.

15. **Anti caking agents:** to avoid the caking of feed ingredients some agents like calcium phosphate, potassium and sodium ferrocyanide, magnesium oxide, kaolin, hydrated sodium calcium aluminosilicate (HSCAS) are added as these additives absorb moisture without being wet.

16. **Buffer:** some chemicals such as sodium bicarbonate, magnesium oxide, calcium carbonate, sodium bentonite etc. Are added in the diet to maintain the normal pH.

17. **Surfactants:** also known as **surface-active agents**, can act similarly to antibiotics or arsenicals by selectively inhibiting certain intestinal microorganisms. They work by altering the microbial environment or disrupting the cell membranes of specific bacteria. This property makes surfactants valuable as feed additives to improve gut health, nutrient absorption, and overall animal performance. Eg. Alkyl benzene sulphonate, lauryl ethylene oxide condensate, ethmiod C-15.

18. **Defaunating agents:** these are the agents used for the removal of ruminal fauna. Eg. Copper sulphate, sodium lauryl sulphate, oil rich in PUFA and dioctyl sodium sulphosuccinate.

19. **Ketosis controlling agents:** sodium propionate, propylene glycol, sodium acetate etc. Are used as feed additives for controlling the ketosis.

20. **Acidifiers/organic acid:** Acidifiers, particularly organic acids, are widely used as feed additives in livestock and poultry diets to improve gut health, enhance nutrient absorption, and inhibit the growth of harmful bacteria. These compounds help to maintain an optimal gut environment by reducing pH levels, promoting beneficial microorganisms, and suppressing

pathogenic ones. Eg, Formic Acid, propionic acid, acetic acid etc. Formic Acid Lowers feed and gut pH, inhibits harmful bacteria like *Salmonella* and *E. coli*. and often used in poultry and pig feeds as a preservative and antimicrobial agent.