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Feed Additives and Their Use in Animal Nutrition

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Introduction

Feed additives are commonly described as non- nutrient substances that accelerates growth, efficiency of feed utilization, or beneficial for health, or metabolism of the animal. Feed additives is an ingredient or combination of ingredients added to the basic feed mix or parts thereof to fulfil the specific need. Usually used in microquantities and requires careful handling and mixing. It is used to improve rate of gain, feed efficiency, preventing and controlling disease, prevention against untoward environmental influences and economise the cost of animal protein. Mainly feed additives categorize in two categories, first one is Nutrient feed additives (amino acids, minerals, and vitamins) and second is Non nutrient feed additives (antibiotics, hormones, immunomodulators, enzymes, probiotics).

Various types of feed additives

A. Antibiotics

Non Ionophore antibiotics (chlortetracycline, zinc bacitracin etc.) and Ionophore antibiotics (monensin, lasalocid, salinomycin etc.) are two group of antibiotics which is majorly used as antibiotic growth promoters (AGPs). Difference in between two is their mode of action. Ionophore antibiotics form hydrophobic complex with inorganic cations like sodium potassium and calcium. Mainly active against gram positive organisms because outer membrane of gram-negative bacteria is impermeable to such complexes. AGPs impart their effect by stimulating the microorganisms in gut which favours nutrient synthesis, suppression organisms which compete for critical nutrients and, inhibit toxin producing bacteria. Ionophore and non-ionophore have been used in non-ruminants and pre-ruminants while, only ionophore are successfully used in adult ruminants. The use of AGPs led to increasing number of cases, where antibiotic-resistant bacteria were isolated. This fact has raised serious public health concerns in several countries, leading to either a complete ban or strict restrictions on the use of AGPs. It expanding options for the use of alternative feed additives. In this context, phytogenic feed additives are searched to be incorporated in poultry feed as growth promoters.

B. Phytogenic Feed Additives

Phytogenics are a group of natural growth promoters (NGPs) or non-antibiotic growth promoters used as feed additives, derived from herbs, spices or other plants (e.g., garlic, oregano, thyme, rosemary, coriander, and cinnamon) as well as to their respective plant extracts in the form of essential oils. They are commonly regarded as favourable alternatives feed additives to antibiotic growth promoters (AGPs) in poultry production. Phytogenic feed additives consist of a broad variety of substances, mainly extracts from plant materials, such as flowers, buds, seeds, leaves, twigs, bark, herbs, wood, fruits, and roots. It was reported that these products of plant origin are natural, less toxic, residue free and ideal feed additives for animal when compared to synthetic antibiotics or inorganic chemicals. Phytogenic substances have antimicrobial, antifungal, antiparasitic, antiviral, antioxygenic and insecticidal properties. Phytogenic feed additives are either available in a solid, dried, and ground form or as extracts or essential oils. Moreover, active components of herbs may improve digestion and stimulate the immune function in poultry.

Herb/species	Latin name	Active principle
Ginger	*Zingiber officinale*	Gingerols and shogaols
Garlic	*Allium sativum*	Allicin (diallyl-thiosulfinate)
Cinnamon	*Cinnamomum verum*	Cinnamaldehyde
Thyme	*Thymus vulgaris*	Thymol

C. Arsenicals

3-nitro-4hydroxy phenylarsonic acid (3 nitro), P-amino phenylarsonic acid (arsanilic acid) are example of arsenicals. It improves the growth of broilers and such birds have bright red combs and wattles as it enlarges the capillaries due to its dilator effect.

D. Copper supplements

Routinely used in pig diet as growth promoter. Copper sulphate is added at 0.01% of diet in fattening pigs. It also causes partial defaunation (removal of protozoa from rumen) in ruminants which ultimately result in less protein loss.

E. Hormones

Mainly two categories of hormones are being used in animal feed as feed additive. First category are anabolic hormones **(**Somatotropin, Thyroxin and Androgens etc.), they stimulate growth of endochondral bones and epiphysis of long bones and aid in nitrogen retention during protein metabolism. Second category of hormones are catabolic Hormones (Oestrogens, glucocorticoids), they inhibit skeletal growth and degrading protein and amino acid.

F. Immunomodulators

They are obtained from organisms or synthesized chemically which can enhance the defence mechanism. e.g., Vitamin C, Vitamin E, Levamisole, quaternary ammonium compounds, chitin.

G. Enzymes

They are usually used with some unconventional feed stuff. The enzymes act in number of ways. First, they can improve the availability of nutrients from plant by break down of impermeable cell wall structures (Cellulase, Hemicellulase). Second, they destroy materials that interfere with the utilisation of nutrients (Beta-glucanase, Xylanase). In non-ruminants phytase enzyme used for enhancing the bioavailability of phosphorus in cereal-based diet. Protease, amylase, lipase etc. enzymes are supplemented to early weaned animal (lower endogenous enzyme production)

H. Probiotics

Parker coined the term Probiotics It is live culture of non-pathogenic (*Lactobacillus acidophilous*, *L. casei*, *L. bifidus* etc.) organisms which beneficially affect the host animal by improving its intestinal microbial balance. They benefit the host by having a direct antagonistic effect against specific group of undesirable or harmful organism through production of antibacterial compounds, eliminating or minimising their competition of nutrients. Altering the pattern of microbial metabolism in the gastro intentional tract, stimulation of immunity and neutralisation of enterotoxins formed by pathogenic organism. Thus, resulting in increased growth rate, improved feed efficiency.

I. Prebiotics

They are complex carbohydrates (oligosaccharides) soluble in water extracted from yeast cell wall, consisting of 2 to 10 monomeric units. They resist attack by the digestive enzymes of animals and therefore not metabolized directly by the host. They interact with the microbial flora

act as specific growth substrates and alter cell adhesion and immunomodulation. When used in mixed amounts in feed (below 1%) oligosaccharides increases weight gain and improves health status. Effects vary as per type of oligosaccharide employed, the class of animal, its age, animal species and management conditions. A wide variety of oligosaccharides such as mannose-oligosaccharide (MOS) fructo- oligosaccharide (FOS), gluco- and galacto- oligosaccharides is commercially available as feed additives. MOS blocks the attachment of harmful bacteria and prevent their colonization. FOS enhance the growth of probiotic bacteria which reduces harmful bacteria.

J. Organic acids

They are usually added as preservative, but their addition to pig diets at higher level has proved beneficial in terms of nutrient digestibility, growth and FCR. Formic and propionic acids are more effective than fumaric or citric acids. Suggested levels of inclusion of acid (kg/tonne diet) are: formic 6-8; propionic 8-10; fumaric 12-15; citric 20-25.

K. Antioxidants

Vitamin E, Vitamin C (Natural), Butylated hydroxy anisole (BHA), Butylated hydroxytoluene (BHT) (Synthetic) are added in feed to avoid rancidity by scavenging free radicals. Certain metals like copper, iron can act as pro-oxidant catalytic and therefore need to the immobilised, sequestrants (Calcium-EDTA, polyphosphates and citric acid) are compounds added to do this. They are metal scavengers binds with metals (copper and iron) which acts as catalyst in oxidation process.

L. Xanthophylls

Xanthophylls enhance the colour or quality of the marketed product. In poultry production we often enhance the yellow colour by incorporating xanthophylls into broiler feed.

M. Grit

Poultry do not have teeth to grind any hard grain, most grinding takes place in the thick muscular gizzard. The more thoroughly feed is ground, the more surface area is created for digestion and subsequent absorption. Hence, when hard, coarse, or fibrous feeds are fed to poultry, grit is sometimes added to supply additional surface for grinding within gizzard. When mash or finely ground feeds are fed, the value of grit become less. e.g., oyster shells, coquina shells and limestone are used as grit. A level of 4% oyster shell together with 3.5% grind limestone which ultimately resulting in total 3.5% dietary calcium, optimum for layer.

N. Rumen modifiers

During maximum production stage ruminants are given high doses of concentrate feeds for meeting demands for extra energy and protein requirement of the animal. The condition on the other hand lowers the pH of the rumen. Since many of the rumen microbes cannot tolerate low pH environment, the normally heterogeneous balanced population of microbes become skewed, favouring the acidophilic bacteria. The condition often leads to acidosis and thereby upsets normal digestion. The addition of feed buffers and neutralisers shown to have beneficial effects. Commonly used buffers and neutralisers are carbonates, bicarbonates, hydroxides, oxides, salts of VFA, phosphate salts, ammonium chloride and sodium sulphate etc. Buffers like sodium bicarbonate and magnesium oxide are used routinely in dairy cattle, to counteract the depression in milk fat synthesis due to low ruminal pH and reduced acetate/propionate ratio induced by a lower roughage and high grain diet. Sodium bicarbonate should be @ 0.6 to 0.8 percent of a total mixed diet and 1.2 to 1.6 percent of a concentrate mixture. Magnesium oxide should be added @ 0.2 to 0.4 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 $NaHCO_3$ should be mixed with one-part MgO. Feeding large amounts of these mineral may depress feed intake.

O. Chelates

Chelates aid in transport and to store metal ions. Chelates behave as a carrier for proper absorption, transportation in the circulatory system

and passing across cell membranes to deposit the metal ion at the site where needed. Among amino acids, cysteine and histidine are particularly effective metal binding agents and may be of primary importance in the transport and storage of mineral elements throughout the animal body. Ethylene diamine tetra acetic acid (EDTA) and other similar synthetic ligands also may improve the availability of zinc and other minerals.