
UNIT 3 FEED ADDITIVES AND TOXICANTS

Structure

- 3.0 Objectives
- 3.1 Introduction
- 3.2 Feed Additives
 - 3.2.1 Acidifiers
 - 3.2.2 Adsorbents
 - 3.2.3 Antibiotics
 - 3.2.4 Antioxidants
 - 3.2.5 Arsenicals
 - 3.2.6 Coccidiostats
 - 3.2.7 Enzymes
 - 3.2.8 Herbal Products
 - 3.2.9 Nitrofurans
 - 3.2.10 Pre-biotics
 - 3.2.11 Pro-biotics
- 3.3 Exogenous Toxicants in Feed
 - 3.3.1 Argemone
 - 3.3.2 Insecticides/Pesticides
 - 3.3.3 Mycotoxins
 - 3.3.4 Rancid fat
- 3.4 Endogenous Toxicants in Feed
 - 3.4.1 Cyanogens
 - 3.4.2 Goitrogens
 - 3.4.3 Gossypol
 - 3.4.4 Non-Starch Polysaccharides
 - 3.4.5 Phytates
 - 3.4.6 Tannins
 - 3.4.7 Trypsin Inhibitors
- 3.5 Let Us Sum Up
- 3.6 Glossary
- 3.7 Suggested Further Reading
- 3.8 References
- 3.9 Answers to Check Your Progress

3.0 OBJECTIVES

After studying this unit, you should be able to:

- discuss about different feed additives used in poultry ration; and
- summarise the exogenous and endogenous toxicants in feed.

3.1 INTRODUCTION

The poultry feed is a mixture of various feed ingredients providing many essential

nutrients. As you know that the feed is one of the important requirements in poultry farming and hence maximum care is required. Any alteration in feed quality will directly affect the production of eggs and meat as well as the health of the birds by causing several deficiency signs of nutrients. It is also very much required to boost the production of eggs and meat through feeding of balanced feed. In addition to many essential nutrients, the nutritive or non-nutritive substances are also added in diet to boost up the performance and production. You should be very much alert to keep watch on various adverse factors or toxicants that encounter the quality of feed and finally affect the profit of poultry farming. In view of above, you will learn about the common feed additives and feed toxicants in poultry nutrition.

3.2 FEED ADDITIVES

The feed additives have been defined as ingredients of non-nutritive nature or mixture of ingredients added to the basic feed mix or parts thereof, usually in small quantities to accelerate growth, feed utilization, egg production and health. The feed additives are also known as **growth promoters, growth stimulants, performance enhancers, performance improvers, nutraceuticals** etc. While performing to fullest level of growth, production and reproduction, the birds are more prone to infections, diseases and stress and thus they require better rearing practices and welfare. Therefore, the addition of feed additives which enhances the growth and other type of performance such as egg production, feed utilization etc. may be beneficial to the birds. Some common feed additives have been discussed in this section.

3.2.1 Acidifiers

Acidifiers are acids and can be included in the feed in order to lower the pH of the feed. It also helps in slowing down the growth of pathogenic intestinal bacteria which reduces the microflora competing for the host nutrients and results in better growth and performance of the chicken. Some commonly used compounds are benzoic acid, fumaric acid, lactic acid, butyric acid, formic acid and propionic acid. The acidifiers can be added in feed at the rate of 0.2 to 1%.

3.2.2 Adsorbents

Any substance having capacity to adsorb (attach to) anti-nutritional factors or toxins is known as adsorbent or toxin binder. The use of adsorbents in poultry ration is in practice to avoid feed toxicity. Several substances like activated charcoal, aluminosilicates, bentonite (sodium bentonite more effective than calcium bentonite), MOS (mannan oligosaccharides), silicon, zeolites etc. have been found to be beneficial in minimizing the toxic effects of feed mycotoxins. Hydrated Sodium Calcium Alumino Silicate (HSCAS) at the dose rate of 0.5% i.e. 5 g per kg diet protects the broilers and White Leghorn chicks from toxic effects of aflatoxin B₁ by way of making aflatoxin unavailable for absorption.

3.2.3 Antibiotics

The compounds required in low dose and having bactericidal (bacteria killing) or bacteriostatic (stops bacterial growth) properties are known as antibiotics. The most common antibiotics used in feed or water to poultry are bacitracin, chlortetracycline, flavomycin, lincomycin, oxytetracycline, penicillin and streptomycin. Though the use of antibiotics as feed additives has been banned in many parts of the world due to their residual effects on human health and development of antibiotic resistant strains, but the experience has not been satisfactory as the incidence of diseases increases

from time to time. The inclusion level of any antibiotic in poultry diets is usually kept as per the instructions mentioned on the product. However, you can provide antibiotic of narrow spectrum @ 4 g per tonne and broad spectrum @ 10 g per tonne.

3.2.4 Antioxidants

High fat ingredients such as animal (fish meal, meat meal and poultry by-product meal) or vegetable fats or oils are usually employed in poultry rations. These ingredients are susceptible to auto-oxidative rancidity which ultimately reduces the palatability, quality and nutritive value of feed. Any natural or synthetic agents that prevent the auto-oxidative rancidity in feed are called as antioxidants. Antioxidants help preserve nutritive value and freshness of the diet. These also maintain the potencies of fat soluble vitamins such as A, D, E and K. Butylated Hydroxy Anisole (BHA), Butylated Hydroxy Toluene (BHT) and ethoxyquin, as synthetic antioxidant, are directly added to the mixed feed @ 125 mg per kg feed. Selenium (100-150 mcg/kg), Vitamin C (0.1 to 1 g/kg) and E (15-30 mg/kg) are good source of natural antioxidants.

3.2.5 Arsenicals

These are used as growth promoters for improving feed efficiency and egg production. They also act as growth inhibitors of pathogenic organisms. The commonly used arsenicals are arsanilic acid, sodium arsanilate and 3-nitro-4-hydroxyphenyl arsenic acid in poultry rations. Mixing level is 40 to 90 mg per kg feed. Though the amount of arsenic retained in the tissues is very low, it is advisable to withdraw the arsenicals from feed at least 5 days before the slaughter.

3.2.6 Coccidiostats

Any agent protecting the flock from coccidiosis (infection of coccidia) is known as anti-coccidial or coccidiostat. These are routinely used in poultry rations. Some of the products include amprolium, arprinocid, DOT (3, 5-dinitro-toluamide), furazolidone, halofuginone, metichlorpindol, nicarbazine quinoline, robenidine, sulphamezathine, etc.

3.2.7 Enzymes

The enzymes are biological catalysts which are protein in nature and are produced by every living organism. The use of enzyme supplements in diet to improve nutritional value has been very common now-a-days. Some common enzyme supplements include arabinoxylanases, beta glucanase, cellulase (200 units/kg), hemicellulase, pectinase (400 units/kg), phytase (500-700 units/kg), xylanase (1000 units/kg) etc.

3.2.8 Herbal Products

Many herbal products have been used to maintain good health of animals. Now-a-days, several herbs and their preparations have come to the market for use as feed additives to enhance bird's performance, improve feed efficiency and maintain health. A few herbal products grouped under anti-stress factors, coccidiostats, growth stimulants, immuno-modulators and liver tonics are being used in poultry feeding.

3.2.9 Nitrofurans

These are anti-bacterial compounds effective against large number of disease causing micro-organisms. They are partly effective against cocci. Furazolidone and nitrofurazone are commonly used as nitrofurans. In combination with antibiotics, the nitrofurans give good result. The dose of furazolidone in broiler diet is 100 mg per kg.

3.2.10 Pre-biotics

The pre-biotics are non-digestive feed components that benefit the birds by increasing the growth rate and proliferation of host-favourable bacteria in colon and thus improve the health of the birds. Any feed ingredient entering large intestine as such is a pre-biotic. The pre-biotics attract microbes away from the intestinal binding sites and therefore reduce colonization of pathogens. The oligosaccharides (MOS-mannan oligosaccharides) and lactose derivatives have been tried as pre-biotics to combat colonization of pathogens.

3.2.11 Pro-biotics

The gut of a newly hatched chick is sterile (without any bacteria) but later it gets loaded with microbes from the environment. The gut (gastro intestinal tract) of birds contains about 400 types of bacteria. Some of them are pathogenic (harmful) and some non-pathogenic (favourable). In normal conditions, the gut microflora are in balanced state. Harmful microbial population increases due to stress, disease conditions and antibiotic treatment. The pro-biotics are live microbial feed supplements that benefit the bird by establishing a host-favourable intestinal microbial balance, nutrition, growth, health and immuno-competence. They should be non-pathogenic and non-toxic. Some of the common pro-biotics include *Lactobacillus acidophilus*, *Lactobacillus bulgaricus*, *Streptococcus lactis*, *Streptococcus faecium* and yeast culture.

Check Your Progress 1

Note: a) Use the space given below for your answers.
b) Check your answers with those given at the end of the unit.

1) Define the following:

i) Acidifiers

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ii) Anti-oxidants

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iii) Adsorbents

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iv) Coccidiostats

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v) Enzymes

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- 2) What is the difference between pre-biotic and pro-biotic?

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Activity 1

Visit a nearby poultry farm and note down different types of feed additives along with their composition or ingredients used in poultry feed.

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3.3 EXOGENOUS TOXICANTS IN FEED

Feedstuffs in general supply several essential nutrients to poultry for growth, production and reproduction. In addition to these beneficial nutrients, the feedstuffs incorporated in compounded feeds are also known to contain wide varieties of anti-nutritional factors (toxicants) that are exogenous and endogenous in nature and adversely affect the performance. Therefore, the removal or processing of these toxicants is absolutely necessary to ensure good health and profitable poultry production. The feed based exogenous (external) toxins concerned in poultry feeding may be divided into the following groups:

3.3.1 Argemone

Due to high oil content and cheap availability, the seeds of *Argemona mexicana* are used as adulterant with mustard seed and its cake during the extraction. Blindness, cancer, diarrhoea, glaucoma, oedema and swelling of leg are the signs of argemone toxicity. Heating the mustard seeds at 240°C for 5 minutes may damage the argemone.

3.3.2 Insecticides/Pesticides

The insecticides/pesticides may be categorized into four types as follows:

- Chlorinated hydrocarbons such as aldrin, benzene-hexachloride (BHC), dichloro-diphenyl-trichloroethane (DDT),
- Organophosphate compounds such as malathione, parathione (methyl parathione) and sumithione,
- Carbonate compounds such as carbaryl, pyrolan, and
- Synthetic pyrethroids such as allethrin and fenvalerate.

Residual amount may affect the quality and proper utilization of feedstuffs by the poultry and may cause drop in performance and production and finally leads to mortality. Fenvalerate and methyl parathione beyond levels of 100 ppm and 25 ppm, respectively adversely affect the performance of broilers.

3.3.3 Mycotoxins

Grains and forage crops under certain circumstances are infested with several species of saprophytic fungi or moulds liberating secondary metabolites as toxins known as

mycotoxins. Mycotoxin can be understood as myco=fungus; toxin=poison i.e. fungal poison. All mycotoxins are not toxic to poultry. Birds may show feed intake reduction or feed refusal, alteration in nutrient and suppression of immunity. Fungi infestation reduces crude protein and metabolizable energy contents of the feed but increases ash content. Palatability of mould infested grains reduces drastically. Some of the important mycotoxins are aflatoxins, citrinin, ochratoxin A, rubratoxin B, and T-2 toxin. Mycotoxins produce the condition known as mycotoxicosis.



Fig. 3.1: Mould infested maize

i) Aflatoxins

Aflatoxin stands for a=aspergillus; fla-flavus, toxin-poison i.e. toxin from *Aspergillus flavus*. The aflatoxin is a toxin produced by a fungus known as *Aspergillus flavus* and *Aspergillus parasiticus*. It occurs in almost all feedstuffs contaminated with this fungus during harvesting, processing, storage, transportation etc. Cottonseed meal, groundnut cake and maize are more prone to be contaminated. Depending on their colour under the fluorescent/ultraviolet lamp the aflatoxins are of four types: B₁, B₂, G₁ and G₂. B₁ is most pathogenic to poultry as compared to B₂, G₁ and G₂. High moisture (more than 12%), excess humidity (more than 80% relative humidity), optimum temperature (24-27°C), longer storage in ill-ventilated godowns and poor hygienic conditions may impose threats and risk for fungal contamination. The aflatoxin causes a condition known as aflatoxicosis leading to serious health hazard to poultry. Aflatoxicosis is characterized by toxicities of kidney and liver and suppression of immunity. Important signs in broilers include dehydration of comb and shank, jaundice, loss of appetite, poor feed utilization, reduced weight gain, vascular haemorrhage and high mortality. Important signs in layers include low egg production, reduced egg weight, poor feed utilization, low hatchability and embryonic defects.

ii) Citrinin

The citrinin is nephrotoxic similar to ochratoxin and is produced by some of the fungi that also produce ochratoxin. It is found in barley, oats and wheat. Important clinical sign noticed in chicks include increased water intake, enhanced excretion of water in faeces, decreased weight gain and poor feed efficiency.

iii) Ochratoxins

The ochratoxins are produced by *Aspergillus alutaceus*, *Aspergillus ochraceus* and *Penicillium verrucosum*. There are two types of ochratoxin i.e. A and B. Barley, maize, oats, rye and wheat are generally contaminated by ochratoxins. Important signs include bleeding in mucosa of proventriculus, catarrhal enteritis, decreased weight gain, dehydration, emaciation, poor feed efficiency and kidney damage in young chicks fed diets with 2 ppm of ochratoxins. Important signs in layers fed diet with 3 ppm ochratoxins include delayed maturity, reduced egg production, poor feed utilization, poor hatchability and immuno suppression. The ochratoxins also cause lesions in kidney and liver.

iv) T-2 toxin

The T-2 toxin is also known as trichothecenes and produced by fungus *Fusarium tricinctum*. Anorexia, crusty lesion on lower and upper mandibles of the mouth,

dermatitis, diarrhoea, feed refusal, gizzard lesion, incoordination, intestinal degeneration, reduced growth and immuno suppression in young chicks fed diet with 3 ppm of T-2 toxin has been noticed. In layers, low egg production, poor feed efficiency, poor hatchability and thin shelled eggs have been observed.

v) Prevention of mycotoxin

Activated charcoal @ 1-2 g/kg feed, clays, hydrated sodium calcium alumino silicate @ 2-4 g/kg feed and zeolite are good toxin binders. It can attach to the toxins and can help in prevention of mycotoxin.

3.3.4 Rancid Fat

When you are feeding fish meal, rice bran, rice polish and silkworm pupae meal to poultry, you may notice that these stuffs are very prone to undergo rancidity, if these are not properly stored. The rancid fat is a powerful destroyer of fat soluble vitamins such A, D, E, and K, besides decreasing the palatability of finished feed. You may have to avoid such rancidity and for this you have to add any one antioxidant at the rate of 0.01% in poultry diets. Some common antioxidants are butylated hydroxyl anisole (BHA), butylated hydroxyl toluene (BHT), ethoxyquin etc.

Check Your Progress 2

Note: a) Use the space given below for your answers.

b) Check your answers with those given at the end of the unit.

1) Write True or False

- i) Aflatoxins are harmful to birds.
- ii) BHA is an anti-oxidant.
- iii) Fat destruction can be checked by ethoxyquin.
- iv) High mortality is seen in aflatoxicosis.
- v) Mycotoxins are useful to birds.

2) How mycotoxins can be prevented?

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3.4 ENDOGENOUS TOXICANTS IN FEED

Several feed ingredients whether conventional or unconventional are known to contain endogenous (natural) anti-nutritional toxic factors in variable amounts. It is always advisable to detoxify these unwanted elements so that the adverse effects on the performance of poultry may not be noticed.

3.4.1 Cyanogens

Intact form of cyanogens may not be toxic. Cassava meal (tapioca meal), linseed meal and safflower meal contain cyanogens. These are toxic when hydrolyzed to release hydrocyanic acid (HCN). Signs of HCN poisoning include abnormal

respiration, blue colouration of mucous membrane, convulsions and nervousness. Steam cooking may help in inactivation of HCN.

3.4.2 Goitrogens

The goitrogenic products are released on hydrolysis of glucosinolates or thioglucosides present in mustard or rapeseed meal. It causes enlarged thyroid gland known as goitre. Safe level of goitrogen is 0.03 to 0.4% in chicks. It may be removed by extraction of meal with acetone, alkali, iron or water.

3.4.3 Gossypol

A phenol like compound known as gossypol is present in cotton seed meal. More than 0.06% free gossypol in diet depresses growth in chicks. Ascitis, cardiac irregularity and low feed intake have also seen in gossypol toxicity. Gossypol more than 0.005% causes olive green discolouration of egg yolk. Addition of 1-2 ppm of iron for every 1 ppm of free gossypol may help tolerance of high level of gossypol.

3.4.4 Non-Starch Polysaccharides

Polysaccharides (complex carbohydrates) other than starches are known as non-starch polysaccharides (NSP). The NSPs increase gut viscosity thereby reducing absorption of nutrients (lipids, proteins, starch) which will lead to wet and sticky droppings, more excreta volume, excess foul odour in houses and increased number of pathogens. Major part of dietary fibre include cellulose, chitin, glucans, gums, mucilages, pectins and exclude lignin. Good sources of insoluble NSP include: corn, rice and wheat. Good sources of soluble NSP include: barley, beans, oats and Rye. Birds lack enzymes needed to digest NSP. Application of heat, milling to expose cell wall contents and enzyme supplementation can remove NSP.

3.4.5 Phytates

Calcium and magnesium salts of phytic acid are known as phytin. Relatively high concentrations of phytate/phytic acid occur in wholegrain cereals, brans and oilseeds. This phytin phosphorus is not available 100% to poultry because they lack the digestive phytase enzyme required to separate phosphorus from the phytate. Only 33% of phytin phosphorus is available to birds. Supplementation of microbial phytase enzyme in diet improves the utilization of calcium, phytate phosphorus and trace minerals.

3.4.6 Tannins

Canola/mustard/rapeseed meal, cottonseed meal, groundnut cake, jowar/sorghum, mango seed kernel meal and salseed meal contain variable amount of tannins. More than 0.5% tannins cause reduction in growth. It can be removed by cold water soaking, boil water processing, acid treatment, alkali treatment, solvent extraction etc.

3.4.7 Trypsin Inhibitors

The trypsin inhibitors are also known as anti-trypsin or protease inhibitors. Reduced growth and low production are deleterious effects of trypsin inhibitor. These are present in alfalfa meal, guar meal, rapeseed meal, soybean meal, sunflower meal and wheat. Autoclaving of soybean meal under 5 lb/in² for 45 minutes or 20 lb/in² for 10 minutes would destroy anti-trypsin activity.

Check Your Progress 3

Note: a) Use the space given below for your answers.

b) Check your answers with those given at the end of the unit.

1) List out the common endogenous toxicants of the feed.

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2) What are the deleterious effects of trypsin inhibitors?

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3.5 LET US SUM UP

In addition to many essential nutrients, the nutritive or non-nutritive substances are also added in poultry diet to boost up the performance and production. The feed additives have been defined as ingredients of non-nutritive nature or mixture of ingredients added to the basic feed mix or parts thereof, usually in small quantities to accelerate growth, feed utilization, egg production and health. While performing to fullest level of growth, production and reproduction, the birds are more prone to infections, diseases and stress and thus they require better rearing practices and welfare. Therefore, the addition of feed additives enhancing the growth and other type of performance such as egg production, feed utilization etc. may be beneficial to the birds. Some of the common feed additives used in poultry ration include acidifiers, adsorbents, antibiotics, antioxidants, arsenicals, Coccidiostats, enzymes, herbal products, Nitrofurans, pre-biotics and pro-biotics. The common exogenous toxins found in feed are argemone, insecticides, Mycotoxins and rancid fat. Some of the common endogenous toxicants in feed are cyanogens, goitrogens, gossypol, non-starch polysaccharides, phytates, tannins and trypsin inhibitors.

3.6 GLOSSARY

Adsorbent	: Any agent reducing the toxicity or toxins in bio-system by attaching to it.
Aflatoxin	: Toxin liberated by a fungus known as <i>Aspergillus flavus</i> .
Coccidiostat	: Any agent preventing the growth of cocci organism which caused the Coccidiosis diseases.
Feed Additive	: An ingredient of non-nutritive nature that increases growth, feed utilization, egg production and health.
Gossypol	: Phenol like compound present in cottonseed meal and acting as anti-nutritional factor.

Phytate	: Salt of phytic acid present in plants.
ppm	: parts per million; 1 part in 10,00,000 parts.
Pre-biotic	: Non-digestive feed components that benefit the birds by increasing/stimulating the growth rate and or proliferation of one or more of a limited number of bacteria in the colon and thus to improve the health of the birds.
Pro-biotic	: Live microbial feed supplement that benefit the birds by establishing a favourable intestinal microbial balance, nutrition, growth and health.
Trypsin Inhibitor	: Any agent reducing the activity of trypsin protein.

3.7 SUGGESTED FURTHER READING

Banday, M.T. and Mondal, S.S. 2002. *Poultry Feeding and Nutrition*. Pixie Publication India (P) Ltd., Karnal.

Mandal, A.B., Yadav, A.S., Johri, T.S. and Pathak, N.N. 2004. *Nutrition and Disease Management in Poultry*. International Book Distributing Company, Lucknow

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Saxena, U.C. 2000. *A Handbook of Poultry Feeding and Management*. Pixie Publication India (P) Ltd., Karnal.

3.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

- 1)
 - i) Acidifiers are acids and can be included in the feed in order to lower the pH of the feed. It also helps in slowing down the growth of pathogenic intestinal bacteria which reduces the microflora competing for the host nutrients and results in better growth and performance of the chicken.
 - ii) Any natural or synthetic agents that prevent the auto-oxidative rancidity in feed are called as antioxidants. Antioxidants help preserve nutritive value and freshness of the diet.
 - iii) Any substance having capacity to adsorb (attach to) anti-nutritional factors or toxins is known as adsorbent or toxin binder. The use of adsorbents in poultry ration is in practice to avoid feed toxicity.
 - iv) Any agent protecting the flock from coccidiosis (infection of coccidia) is known as anti-coccidial or coccidiostat.
 - v) The enzymes are biological catalysts which are protein in nature and are produced by every living organism.
- 2) The pre-biotics are non-digestive feed components that benefit the birds by increasing the growth rate and/or proliferation of host-favourable bacteria in colon and thus to improve the health of the birds. Any feed ingredient entering large intestine as such is a pre-biotic. But, pro-biotics are live/living microbial feed supplements that benefit the bird by establishing a host-favourable intestinal microbial balance, nutrition, growth, health and immuno competence.

Check Your Progress 2

- 1)
 - i) True
 - ii) True
 - iii) True
 - iv) True
 - v) False
- 2) Activated charcoal (1-2 g/kg feed), clays, hydrated sodium calcium aluminosilicate (HSCAS @ 2-4 g/kg feed) and zeolite are good toxin binders. It can attach to the mycotoxins and can help in their prevention.

Check Your Progress 3

- 1) The common endogenous toxicants present in the feed are cyanogens, goitrogens, gossypol, non-starch polysaccharides, phytates, tannins and trypsin inhibitors.
- 2) The trypsin inhibitors are also known as anti-trypsin or protease inhibitors. Reduced growth and low production are deleterious effects of trypsin inhibitor. These are present in alfalfa meal, guar meal, rapeseed meal, soybean meal, sunflower meal and wheat. Autoclaving of soybean meal under 5 lb/in² for 45 minutes or 20 lb/in² for 10 minutes would destroy anti-trypsin activity.