# POULTRY FEED QUALITY
# RAW MATERIAL TO FINISHED FEED

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## Importance

Feed cost is the single largest cost in producing meat and eggs, accounting for nearly 70-80% of the total costs. At first glance, it would appear a relatively simple task to maintain the quality of grain and other feed ingredients from harvest to the day of feeding. However, it can be one of the most difficult tasks related to livestock feeding and feed production. Even a minor loss in quality could result in major business setbacks for both livestock raisers and feed manufacturers.

## I. RAW MATERIAL QUALITY

Quality of the feed that is compounded ultimately is largely dependant on the raw materials used. Hence utmost importance is to be given to the raw material when it arrives at the farm.

### i. Gross examination

Cereals like maize should have glistening coat, germ portion unaffected, insect free, intact grain and without fungal infestation. Milling by-products like deoiled rice bran should be free from adulterants, musty or stale odour, sour or rancid taste and from lumps, dirt and extraneous matter including iron and other metallic pieces. Soya bean meal must be free from roasted soyabeans (dark) and lumps. It should not be powdery. All the materials shall contain moisture at relatively low levels. Grains can be tested for this using instant moisture meters.

### ii. Microscopic examination

Raw materials can be checked for quality by observing appearance under a stereo microscope. This calls for considerable expertise and experience. Adulteration with low-quality/toxic materials like DORB with paddy husk, fish meal with sand or urea and sunflower cake with castor cake can be identified.

### iii. Lab evaluation

Estimation of proximate principles and detection for toxic/antinutritional principles (aflatoxin, other mycotoxins, tannins, glucosinalates, gossypol etc.) in the laboratory gives an accurate assessment of raw material quality. For quick and satisfactory estimation, latest equipment like NIR system may be used for simultaneous estimation of several nutrients within few minutes.

## iv. Quick tests

There are many quick chemical and spot tests developed for testing the presence and absence of a certain chemical substance which influence the quality of the feed. Generally the methods are simple and require minimum measurements and hence can be practiced by farmers.

***a. Salt***

Reagents : Silver nitrate solution (5%)
Nitric acid solution (1:2)
Ammonium hydroxide solution (1:1)
Standard sodium chloride solution (0, 0.1, 0.2, 0.3%)

Procedure : Weigh 1 g of sample and add 100 ml of distilled water. Stir and filter with Whatman no.4. Pipette 1 ml of std. solution and 8 ml of nitric acid solution, Stir and add 1 ml of silver nitrate solution. Stir and compare the test sample with the std., sample. Salt gives a white turbidity.

***b. Urea***

Reagents : Urease solution - dissolve 0.2 g Urease powder in 50 ml distilled water.
Standard urea solution (0, 1, 2, ….5%) Cresol red indicator (0.1%).

Procedure : Weigh 10 g test sample and add 100 ml of distilled water. Stir and filter with Whatman No, 4. Pipette 2 ml of standard solution and test sample into white ml of standard solution and test sample into white plates. Add 2-3 drops of cresol red indicator and add 2-3 drops of Urease solution. Let it stand for 3-5 mts. If urea is present, it will form a deep appearance, in contrast to the yellow colour of the indicator.

***c. Urease activity in soyabean meal***

The Urease enzyme activity of soyabean meal is measured qualitatively by the conversion of urea to ammonia gas in the presence of phenol red indicator. Since, urease activity is correspondent with trypsin inhibitor activity, the test gives an indication of the adequacy of heat treatment applied during solvent extraction.

Reagents : NaOH 0.1N
$H_2SO_4$ 0.1N
Urea -phenol red solution: dissolve 0.14 g of phenol red in 7 ml of 0.1N NaOH and 35 ml of distilled water. Dissolve 21 g Urea in 300 ml distilled water. Mix these two solutions together and titrate to amber colour with 0.1N sulfuric acid.

**Procedure :** Place on teaspoonful of well mixed standard soyabean meals (1, 3, 5, 7, 9, 11% raw soyabean meal) and test sample soyabean meal into a series of petri dishes. Add 5 - 8 drops of amber-coloured phenol red solution. Swirl gently to spread sample evenly wetted in the dishes. Let them stand for 5 minutes and compare the test soyabean sample with the standard soyabean meal samples.

| | | | |
|---|---|---|---|
| Scale reading : | Slightly active | : | few scattered red-purple particles |
| | Moderately active | : | 25% red- purple particles |
| | Active | : | 50% red- purple particles |
| | Very active | : | 75% red-purple particles |
| | Overcooked | : | No red-purple particles even after 5 minutes |

### v. Bulk density of feed stuffs

Bulk density of feed stuffs generally remains constant and presence of other items will change it appreciably.

### vi. Floatation Technique

It is a fast method of determining quality of feed ingredients and percentages of major ingredients in mixed feeds. The technique is adapted from the principle of floatation of feed in combination of solvents of known densities. It is possible by this method to isolate the contaminants and adulterants and also the ingredients from a feed mixture.

#### *Floatation of meat fraction from bone fraction*

Place 10 g of the ingredient in a 100 ml beaker and over it pour 90 ml carbon tetrachloride. Stir well and allow settling. With stainless steel spoon, scrape off the floating meat fraction into filter paper. Clean off the side of beaker and spoon for any of the meat fraction, and then pour off liquid and filter. Pour the liquid and submerged fraction (bone fraction) into another filter paper, rinse the beaker out carefully with carbon tetrachloride and pour into the same filter paper. Place the two fractions in oven at 110° C. Dry for 10 mts and allow to cool. Weigh each fraction.

#### *Floatation of rice products*

Weigh 10 g of sample and place in 100 ml evaporating dish. Over it pour solvent mixture. Stir vigorously. Allow to settle. Using a spoon, scrape off the floating fraction into filter paper. Decant the floating material, taking care not to disturb the settled portion. The floating fraction will be rice hulls. Pour the liquid and submerged fraction onto filter paper. Filter and place the two fractions in oven at 110° C for 10 mts., remove the fractions from the oven and allow to cool and weigh the floating fraction.

Pour the solvent mixture into the submerged fraction. Stir the mixture and allow to settle. Using a spoon, scrape off the floating material into filter paper. Filter and place in oven. This floating fraction will be broken rice. Pour the liquid and submerged fraction into filter paper, filter and place in oven for 10 mts. This will be rice bran.

## II. MANAGEMENT OF RAW MATERIALS & MIXED FEED IN THE STORE

Feed ingredients and mixed feeds are the rich source of vital nutrients. Hence they are highly prone for biological infestation. The principal biological agents that cause loss in quality of stored feed and feed ingredients are microbes, insects and mites, fungi and rodents.

### i. Microbes

Deterioration of feed during storage can be caused by the presence of bacteria in feed. These microbes feed on nutrients for their own survival, growth and reproduction. As their population increases in feeds, the feed's nutritive value decreases and heat is produced. They grow at temperatures above 13°C. Feed

moisture levels above 13-14% and relative humidity of more than 80% favour their multiplication. Broken kernels offer the nutrients, necessary for the growth for microbes. Feed ingredients of animal origin like fish meal, meat and bone meal and blood meal are particularly susceptible. Salmonella plays a unique role. It spreads from animal to man, man to man and man to animal. Infected slaughtered animals contaminate packing plants and animal feeds made from their wastes - **Table 2.**

**Total microbial counts in feed ingredients of different storage qualities**

| Ingredient | Bacterial count (millions/g) | | |
|---|---|---|---|
| | Normal* | Elevated** | Excessive*** |
| 1. Fish meal | 2 | 5 | 6 |
| 2. Maize | 4 | 8 | 8 |
| 3. Meat meal | 1 | 4 | 4 |
| 4. Grains (other than maize) | 6 | 10 | 10 |
| 5.Soyabean meal | 1 | 4 | 4 |
| 6. Oil cakes | 2 | 4 | 4 |

* Permissible ** may be harmful *** definitely harmful, if fed to animals

### *Control measures*

a) Steam pelleting : Heat treatment at 87.5° for 4.1 minutes completely destroys *E.Coli* and *Salmonella* in feed. However during normal pelleting process, microbial counts are considerably reduced but are not completely eliminated.

b) Use of organic acids : Addition of organic acids like propionic acid to feed at concentrations ranging from 0.10-0.25% prior to storage may reduce the bacterial counts substantially. However, for preventing subsequent recontamination other precautions like limiting the moisture content and timely disposal of spoiled feed lots are extremely necessary.

c) Fumigation : Fumigation of feed store with compounds like ethylene oxide may yield some positive results when the feed/grain particle size is less. In pelleted and flaked feed, gas may not be able to penetrate deep into the feed and therefore may not be effective.

## ii. Molds & Mycotoxins

Molds are the principal reason for the destruction of fats in grains during storage, which generally takes place more rapidly than the destruction of either proteins or carbohydrates. Estimated losses in ME of corn due to mold growth range from 5% to 25% depending on the mold species involved. Mold growth reduces all amino acids in the diet, particularly lysine and arginine, and almost all the vitamins. Besides, mold growth in feeds can cause feeds to cake or clump, which generally change colour, consistency and smell and become less palatable. Therefore, animals may refuse to eat molded feed.

Grains with broken kernels are highly prone for the mold growth-**Table 3**, than those with intact kernels. The moisture level for safe storage of different feed ingredients is furnished in the following table.

***Maximum levels of moisture content of raw materials for safe storage***

| Feedstuff | Moisture content % |
|---|---|
| 1. Grains (maize, jowar, wheat, broken rice etc.) | 12-13 |
| 2. Oil cakes and extractions | 10-11 |
| 3. Rice bran and wheat bran | 11-12 |
| 4. Fish meal | 9-10 |

**Table 3.** ***Permissible total mould levels in some feed ingredients***

| | Mould count ('000/g) | | |
|---|---|---|---|
| | **Normal** | **Elevated*** | **Excessive**** |
| 1. Fish meal | 20 | 40 60 | |
| 2. Maize | 50 | 100 | >100 |
| 3. Meal meal | 15 | 45 | >45 |
| 4. Grains | 80 | 200 | >200 |
| 5. Soyabean meal | 25 | 80 | >80 |
| 6. Oil cakes | 50 | 100 | >100 |

* freshness impaired ** spoiled

The fungi that are normally encountered in stored feed ingredients are *Aspergillus restrictus*, *A.glaucus, A.candidus, A.ochraceus, A.versicolor, A.flavus and Pencillium* sps, and *Fusarium* sps.

Molds of certain species produce chemical substances as their metabolites which cause server symptoms when foods containing them are ingested. These toxic substances are collectively called as mycotoxins. Areas having hot and humid climates and poor harvesting and storage practices are particularly the worst sufferers of the problem.

Among the mycotoxins, Aflatoxins, Ochratoxin, Citrinin, Zearalenone (F-2) and T-2 are usually encountered. They are produced by different fungi, as detailed in the - **Table 4.**

| **Toxin** | **Fungi, Primarily responsible** |
|---|---|
| Aflatoxin | *Aspergillus flavus* |
| *A.parasiticus* | |
| Ochratoxin A | *A.ochraceus* |
| *Pencillium viridicatum* | |
| Citrinin | *P.citrinum, P.viridicatum* |
| Zearalenone (F-2) | *Fusapium graminearum* |
| *F.roseum* | |
| T-2 | *F.tricinctum, F.graminearum* |
| *F.roseum* | |

Ingestion of these toxins lead to severe depression in production performance (growth rate in broilers and egg production in layers), immunosuppression, vaccine failure and ultimately increased mortality. Part of the ingested toxins also gets deposited in meat and eggs. Therefore, consumption of such products by humans may result in toxic problems.

### *Controlling mold growth in stored feed ingredients*

***Reduce the duration of storage :*** When the feed is manufactured and consumed shortly thereafter, the probability of mold growth and mycotoxin formation is reduced. This is illustrated in the **Table-5.**

| Age of feed (days) | Aflatoxin (ppb) |
|---|---|
| 1-5 | 7.9 |
| 6-10 | 8.0 |
| 11-15 | 10.7 |
| 16-20 | 27.9 |
| Jones et al (1987) | |

The batch of feed ingredients which was stored first should be evacuated first. Similarly, feed bags lying at the bottom of the stack or at the corners of the godown should also be cleared along with the other bags. Feed ingredients having high moisture content (about 18%) should preferably be used within 10-12 days.

***Effective supervision of the manufacturing process :*** The two fed mill processes which can make a major contribution towards determining the moisture content of finished feeds are grinding and pelleting. When grains are ground, heat is generated due to friction. This causes significant migration of grain moisture which will encourage mold growth. Use of air assisted hammer will help in avoiding this problem. Similarly, during pelletisation of feed, 3-5% moisture is added. This need to be fully removed during subsequent cooling stage.

***Physical condition of the ingredients :*** Physical damage to the grains makes them more vulnerable for fungal attack. Therefore, ground grains and finished feed should be stored under ideal conditions.

***Stacking the bags :*** Keep bagged feed well away (about 1') from the walls of the store. Stack bags on dunnage/crates an air space (10 cm) between the stack and the floor.

***Moisture content of feed :*** Raw materials should be checked for their moisture levels at receipt. If the moisture content of any ingredient is found to be higher than 12-13%, wherever possible, efforts should be made to bring it down by drying. Materials with moisture levels below 12% only should be stored.

***Addition of preservatives :*** Propionic acid or its salts, calcium and sodium propionate (1-3 kg/ton feed) are the effective and least expensive preservatives available for prevention of mold growth. Others like sorbic acid, benzoic acid, gentian violet and copper sulphate are also commonly used for the purpose (400-500 g/ton feed). Solid or liquid forms of these agents work equally well, provided the chemical is evenly distributed in the feed. However for achieving effective results, mold inhibitors should be used in combination with the other listed precautions. It may be noted that the concentration of the inhibitor drops down soon after application as a result of chemical binding. Pelleting of feed enhances the effectiveness of the mold inhibitor. Mold inhibition by use of preservatives reduces the chances for generation of heat in the stored feed and the concomitant spontaneous combustion.

## Spontaneous combustion in feeding stuffs

Feed stuffs like fish, meal, oil cakes, deoiled rice bran and compound feeds with high moisture contents develop lot of heat (50-55°C to even 75°C) during storage and thus become susceptible to spontaneous combustion. This heat is primarily generated by bacteria, fungi and yeast. Therefore, conditions

conducive for the growth of these microbes allow the heat to develop in the feed stuff, if it is stored for long periods. The spoilage may spread throughout the rest of the feedstuff leading to a blackened and charred appearance of the material. Spontaneous heating through oxidation of oil, if present in the feed, may be accelerated

### *Control measures*

1) Drying the feedstuffs prior to storage to moisture levels lesser than 12%.
2) Preventing the development of fungi by addition of suitable mold inhibitors like sorbic acid, salts of propionic acid, benzoic acid and gentian violet etc.
3) Minimising the rate of oxidation of oil in feed during storage by .

a) allowing the oil to oxidise before storage by permitting optimum air flow over the feedstuff.
b) addition of antioxidants like ethoxyquin and butylated hydroxy toluene at a dose rate of 250g to 750g per ton of feedstuff depending on the oil content.

4) Frequent checking of the stored feedstuffs and removal of the portions/bags showing the signs of spoilage.

## iii. Rodents

Rats and mice cause problems wherever cereals are processed and stored. Though they damage the food at various stages, maximum amount of loss is taken place during storage of feed and feedstuffs. Rodents enter the feed store through doors, crevices, holes in walls, roofs, floors and ventilators. Rats multiply very fast. In a year, one pair of rats can produce 1270 rats.

### *Losses*

Rats are voracious eaters. A rat can eat 30-50g of feed a day besides spilling a lot.

The spilled feed and the feed in the superficial portions of gunny bags get contaminated with rat urine, faeces or hair. Feed thus contaminated may develop off odour and may ultimately be rejected by poultry.

Rats are a potential source of diseases both to humans and also animals. They act as carriers of many deadly diseases like typhoid, salmonellosis, fowl cholera, Ranikhet disease, Infectious bronchitis and coccidiosis.

All types of packaging materials (gunny bags, plastic pipe work, cables etc.) are damaged and the cost of repacking or the loss of spilled feed far exceeds the value of feed, actually consumed. Damage to electrical fittings may often lead to electrical short circuits and fire in the godown.

Stored grains, physically damaged by rodents are vulnerable for subsequent mold and insect infestation and thus lose their feeding value.

### *Rodent control measures*

Control measures taken during winter are more fruitful as the population density is very low during this period.

Floors and roofs should be made of concrete and cement.

Spaces or holes in roof, walls and floor should be filled immediately after being noticed.

Doors may preferably be self-closing type.

Ventilators should be properly fitted with wire mesh to avoid rat entry.

Damaged feed and garbage, which serve as breeding grounds for rats should be removed regularly.

Wherever possible, feed should be stored in bins or metal silos which are generally resistant to rodent infestation.

If gunny bags are used for feed storage, they should be stacked over wooden racks, which are of atleast 6" height. Similarly atleast a gap of 1 foot should be left between walls and gunny bag stacks.

Success rates of as high as 80% may be achieved by using mouse traps (Snap trap, break back trap, Hermann trap, wonder trap, cage trap) with flavoured and palatable baits (fruits, vegetables, bread or any other food material).

Rats can be effectively killed by use of rodenticides or chemicals, poisonous to rats - **Table 6.**

### *Single dose agents*

| Compound | Lethal dose |
|---|---|
| Alpha Naphthyl Thiourea | 2.5-6.25 mg/kg body wt. |
| Thallium | 16-25mg/kg body wt. |
| Zinc phosphide | 2.5 - 5.0% concentration in bait material |
| Warfarin | 50 - 150 mg/kg body wt. |
| Brodifacoum | |
| Bromodiolone | 0.005% (liquid) |
| powder | |
| Fluoroacetamide | --- |
| Sqill | --- |
| Strychnine | --- |

### *Fumigation of burrows*

Aluminium phosphide when released into the burrow liberates phosphine, ammonia and carbon dioxide gases, which kill the rat. Burrows should be sealed after fumigation. The compound is commercially available as 5-6g pellets.

## iv. Insects

The grain are rich nutrient sources and hence when stored in a closed environment, with little or no ventilation, combined with high humidity and temperature, become ideal victims for the growth and infestation of insects. The presence of just a few insects from an old batch can lead to generations of millions in a very short time. Extent of insect infestation in stored grains should not be more than 25%. If it is high, nutritive value of grain is affected. The measurement of Uric acid content in infested grains gives an indication of the damage caused by insects.

Insects damage the grain's protective coat and penetrate the nutrient rich inner part of the grain. Thus they reduce nutrient rich grain to worthless dust. In addition, by damaging the seed coat, insects create conditions favourable for mold growth in grains.

At temperature of about 32 °C, the rate of multiplication of insects is very fast and a monthly compound increase of 50 times the present number is often noticed. Thus 50 insects can multiply to more than 312 millions in 4 months.

## *Insect control*

***Sanitation in feed store :*** Feed store has to be frequently checked and spoiled feed lots have to be immediately removed. Wherever possible, completely evacuate the go-down, clean it and then only store the new batch of material. If it is not possible, new grain should be kept separate from old stored grain so as to avoid cross infestation.

***Environmental control of feed store :*** Insects grow comfortably at temperature of 25-30 °C. Therefore, maintenance of temperature at either or lower ranges than this hinders their multiplication.

***Use of insecticides :*** A variety of insecticides are available which can effectively eliminate insects from feed store. They may be either stomach poisons (act after being ingested by the insect) or contact poisons (act after coming in contact with insect body). Contact poisons are generally available as dust, dispersible powders and emulsions.

a) Chlorinated hydrocarbons
   Methoxychlor - suitable for only bin spray and not for spray on grain
   Chlordane, Aldrin, Dieldrin, Endrin, Heptachlor and Toxaphene

b) Organic phosphorus compounds
   Malathion - suitable for direct application over grain and feed store facilities.
   Dichlorovos, DDVP - can be used for surface spraying or as baits/ impregnated resin bars.

## *Fumigation:*

Gas fumigation is very effective method that penetrates the kernel and kills all life stages of insects- eggs, larvae and adult. However, it cannot protect the grain from re-infestation. Therefore, periodical fumigation of feed stores is required for achieving satisfactory results. After the fumigation, once the grain is aerated, no residue of the fumigant will be left in grain.

Examples of some of the commonly used fumigants are aluminum phosphide, calcium eyanide (both powders) carbon tetrachloride, Carbondisulphide, ethylenedibromide, theylene dichloride (all liquids), hydrogen cyanide and methyl bromide (both gases).

## Procedure:

- Seal all crack, holes and close the ventilators and doors hermetically, in order to enable the fumigant to achieve and maintain toxic levels needed to kill the insects.
- Keep all openings closed without being disturbed for atleast 72 hours after the initiation of fumigation.
- Use the right doses of the fumigant as suggested by the manufacturer, regardless of the amount of insect infestation.
- In closed silos, fumigate while the silo is being filled or rotated.
- Fumigate when the air is calm and the temperature is above 21°C and not below 15 °C.