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# RESEARCH ARTICLE

## STABILITY STUDIES ON THE POULTRY FEED NUTRIENTS

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**ABSTRACT**

Feed performance is directly related to the nutrient values present in the feed. Quality control and production department proceed the manufacturing process to maintain the quality measures of output products such as moisture, particle size, hardness and nutrient values. Generally nutrient values are claimed depending on the formulation made by the nutritionist. Nutritionist maintain the nutrient values while making the formula according to the different bird as well as age of the bird. Nutrient values also depend on the proper grinding, mixing as well as proper production processing. Another factors are storage condition and time duration. Time is the important factor for storing the feed and nutrient values are directly related to this. Because there is a possibility tovitiate the nutrient values with time. For these reason we select two categories of feed for the stability study. After continuous observation and chemical analysis within three month, it was found that, there was no significant change in the nutrient values under standard storage condition.



## INTRODUCTION

Feed formulation is the process of quantifying the amounts of feed ingredients that need to be combined to form a single uniform mixture (diet) for poultry that supplies all of their nutrient requirements. Since feed accounts for 65-75% of total live production costs for most types of poultry throughout the world, a simple mistake in diet formulation can be extremely expensive for a poultry producer. Feed formulation requires thorough understanding of the:

- Nutrient requirements of the class of poultry (e.g., egg layers, meat chickens or breeders);
- Feed ingredients in terms of nutrient composition and constraints in terms of nutrition and processing, and
- Cost and availability of the ingredients.

Most large-scale poultry farmers have their own nutritionists (Md. Islam *et al*., 2015) and feed mills, whereas small operations usually depend on consultant nutritionists and commercial feed mills for their feeds.

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It is therefore essential that formulations are accurate because once feeds are formulated and manufactured, it is often too late to remedy any mistakes or inaccuracies without incurring significant expenses (Islam *et al*., 2015). In terms of cost, feed is the most important input for poultry production, and the availability of low-priced, high-quality feeds is critical for the expansion of the poultry industry (Islam *et al*., 2015). For maximum performance and good health, poultry need a steady supply of energy, protein, essential amino acids, minerals, vitamins and most important water. Recent advances in poultry nutrition have focused on three main areas:

- Developing an understanding of nutrient metabolism and nutrient requirements;
- Determining the availability of nutrients in feed ingredients; and
- Formulating least-cost diets that bring nutrient requirements and nutrient supply together.

Practical poultry diets are formulated from a mixture of ingredients, including cereal grains, cereal by-products, fats, plant protein sources, animal by-products, vitamin and mineral supplements, crystalline amino acids and feed additives. In developing countries, the increasing cost and decreasing supply of traditional feedstuffs are expected to constrain the future expansion of poultry production (Islam *et al*., 2015; Shukla *et al*., 2001).

This situation highlights the urgent need to improve utilization of the wide range of alternative feedstuffs available in these countries. In many circumstances, feed resources are either unused and wasted, or used inefficiently. The use of most alternative feedstuffs is currently negligible, owing to constraints imposed by nutritional, technical and socio-economic factors. However, unlike intensive commercial poultry production systems, family poultry units and semi-commercial systems are well-suited to the inclusion of these feedstuffs. A major nutritional problem in developing countries is the biological and chemical contamination of poultry feeds, which may have serious consequences on bird performance and the safety of poultry products for humans. Of the potential contaminants, mycotoxins are the most widespread, particularly in hot, humid conditions, and mycotoxin decontamination must be a part of feeding strategies (Marc *et al*., 2002; Baker, 2000; Gillespie and James, 1987). If poultry are expected to remain healthy and productive, they must consume adequate amounts of all the necessary nutrients. The quantity of each required nutrient varies depending on many variables like species of bird, age, productive state, environmental conditions and disease status. Fortunately, many nutritional deficiency problems can be identified by the unique symptom each exhibits. Animals eat to acquire the energy and building materials that they need to live and grow. Animals use energy to perform normal body functions such as breathing, walking, eating, digesting, and maintaining body temperature (http://agrilifebookstore.org. (2012, October); Leeson and Summers, 2005; http://www.lar.msstate.edu/pdf/Feed%20Storage%20Guidelines.pdf). Nutrients provide poultry the energy and material needed for the development of bone, flesh, feathers, and eggs. Poultry diets must be formulated to provide all of the bird's nutrient requirements if optimum growth and production is to be achieved. There are six classes of nutrients:

- **Carbohydrates** – the major source of energy for poultry. Most of the carbohydrate in poultry diets is provided by cereal grains.
- **Fats** – provide energy and essential fatty acids that are required for some bodily processes.
  **Proteins** – required for the synthesis of body tissue (particularly muscle), physiological molecules (such as enzymes and hormones), feathers and for egg production. Proteins also provide a small amount of energy.
- **Vitamins** – organic chemicals (chemicals containing carbon) which help control body processes and are required in small amounts for normal health and growth.
- **Minerals** – inorganic chemicals (chemicals not containing carbon) which help control body processes and are required for normal health and growth.
- **Water**.

The nutrient requirements of poultry are affected by a large number of factors, including (Amerah *et al*., 2008b):

**Genetics** (the species, breed or strain of bird) – Different species, breeds or strains of bird have different average bodysizes, growth rates and production levels and will absorb and utilise nutrients from feed with different levels of efficiency. Therefore they will require feed with different nutrient compositions. The genetics of commercial poultry is constantly changing, and as a result, so are their nutrient requirements. Consequently, breeders of commercial poultry provide information on the specific nutrient requirements for the birds they sell (Aimradha , 1999; ISI, 1992; Jackson *et al*., 1982).

- **Age** – Nutrient requirements are related to both body weight and the stage of maturity.
- **Sex** – Prior to sexual maturity the sexes have only small differences in their nutrient requirements and males and females can usually be fed the same compromise diet to achieve acceptable growth rates. Differences in nutrient requirements are larger following the onset of sexual maturity and significantly different diet formulations are then required for each sex.
- **Reproductive state** – The level of egg production in hens and sexual activity in males will affect nutrient requirements.
- **Ambient temperature** – Poultry have increased energy requirements to maintain normal body temperature in cold ambient temperatures and the opposite in hot ambient temperatures. Food digestion processes produce body heat, the amount of which will vary according to the nutrient composition of the diet. This is called the heat increment of the diet. In cold temperatures it may be desirable to formulate a diet with a higher heat increment and the opposite in hot temperatures.
- **Housing system** – The type of housing system will influence the level of activity of the birds and therefore their energy requirements.
- **Health status** – Birds experiencing a disease challenge may benefit from an increase in the intake of some nutrients, most commonly vitamins.

How nutrients are destroyed (Sethi *et al*., 1991; Sleman *et al*., 2015; Shariatmadan and Forbes, 1993)

- Oxidation by oxygen in air or by hydroperoxides. Nutrients so destroyed include unsaturated fats, essential fatty acids, vitamins A, C, D, and biotin, and the amino acid lysine.
- Chemical destruction catalyzed by minerals or promoted by high or low pH. This is accelerated with increasing moisture. Vitamin C and thiamine are destroyed at alkaline pH.
- Interaction of aldehydes of carbohydrates (e.g., glucose) or oxidized fats with amino groups. This can occur at room temperature and at usual moisture content in feeds.
- Cleavage of thiamine by sulfite. Destruction of riboflavin by light.
- Fungal growth, nutrient destruction or production of mycotoxins.
  This can occur when local spots within feed or ingredients develop pockets of moisture of about 16%, usually at the edges of the container where moisture has migrated as the temperature fluctuated.
- Bacterial growth will develop if moisture and temperature are favorable. Nutrient degradation and production of toxins occurs readily.

- Insect damage. Grain and grain products are easily contaminated by larvae and beetles that typically grow in grains
- Rodents eat and contaminate grains and feeds.

Although some feed mills produce test diets for evaluation in the laboratory or in feeding trials to confirm the adequacy of the diet, the most important preparation for accurate and economic formulation is to test the chemical composition of the ingredients available for use. Most feed mills today have their own quality control (QC) laboratories. Feed nutrient stability study can be done by wet analysis of individual nutrient within a continuous period of time in the quality control laboratory (19, 20).

## MATERIALS AND METHODS

Nutrient stability can be checked by the wet analysis of feed. The laboratory of a factory is equipped with advanced equipment for laboratory analysis of feed include Kjeldahl, Soxhlet extractor, and ovens which can help to analyze the test chemical, biological, Aflatoxin by experts and professional staffs.Chemical tests are including measurement of moisture, crude protein, crude fat, crude fiber, ash, calcium, phosphorus, salt and Aflatoxin. For stability study, major nutrient values were observed within three month (June, July and August).

**Instrument and equipment**

- Tray and spoon
- Electric balance (Capacity 0.01 gm. to 2500 gm.)
- Glass rod and forceps
- Blender/Sample grinder(Sieve size- 1.0 mm).
- Beaker (Capacity 250 ml) and funnel
- Wash bottle
- Conical flask (Capacity 250 ml.)
- Burette (Capacity 50 ml.)
- Electric oven with time and temperature control
- Moisture tester and IR moisture balance
- Hot plate
- Pipette and measuring cylinder
- Grinder Retsch ZM 200 5:10 (Sieve size- 1.0 mm).
- Filter paper Whatman No. 1 or equivalent.
- Volumetric flask (100ml, 250ml, 500ml)
- Pipette (5ml, 10ml, 25ml)
- Water bath

**Chemicals**

- Ethanol (95%)
- 0.1N NaOH solution
- 0.2 N $H_2SO_4$ solution
- 50% NaOH solution
- Phenolphthalein indicator
- Concentrated HCl acid
- Distilled water
- Mixed indicator
- $Na_2CO_3$
- Ammonium hydroxide; $NH_4OH$ (1:1) water
- Ammonium Oxalate, saturate; $(NH_4)_2C_2O_4$
- Sodium Oxalate; $Na_2C_2O_4$
- Hydrochloric Acid; HCl (1:3) water
- Sulfuric Acid; $H_2SO_4$ (1:5) water
- Nitric acid; $HNO_3$(1: 1) water
- Perchloric acid ($HClO_4$)
- Methyl red indicator
- 0.1 N Potassium Permanganate; $KMnO_4$
- $FeNH_4(SO_4)_2 \cdot 12H_2O$ (Ammonium ferric sulfate or Ferric alum indicator) – 99%
- Nitric Acid ($HNO_3$)-65%
- Ammonium Thiocyanate ($NH_4SCN$)- 98%
- Silver Nitrate ($AgNO_3$)
- Potassium Chromate ($K_2CrO_4$)-95%

**Preparation of chemicals**

- 0.1N NaOH solution
- 4 gm. NaOH with distilled water and total volume will be 1000 ml.
- Phenolphthalein indicator
- 0.5 gm. Phenolphthalein and 50 ml 95% Ethanol are mixed well.
- Catalyst mixer
- 8 gm. $CuSO_4$ + 70 gm. $K_2SO_4$ + Mixed well
- Mixed Indicator
  - 0.2 gm. Methyl Red + 0.1 gm. Methylene Blue+150 ml 95% Ethanol+ Mixed well
- 4% Boric acid solution
- 40 gm. Boric acid+distilled Water=Total volume will be 1 lit. +10 ml Mixed Indicator.
- 50% NaOH
- 500 gm. NaOH + distilled water = Total volume will be 1000 ml.
- 0.2 N $H_2SO_4$
- 11 ml conc. 98% $H_2SO_4$+1989 ml distilled water = Total volume will be 2000 ml.
- Ammonium hydroxide; $NH_4OH$ (1:1)
- 500ml $NH_4OH$+ 500ml Distilled water =Total volume will be 1 liter.
- Ammonium Oxalate, saturate; $(NH_4)_2C_2O_4$
- 42 gm. $(NH_4)_2C_2O_4$ + Distilled water = Total volume will be 1 liter.
- Sodium Oxalate; $Na_2C_2O_4$
- Hydrochloric Acid; HCl (1:3)
- 100ml concentrated HCl + 300 ml distilled water = Total volume will be 1 liter.
- Sulfuric Acid; $H_2SO_4$ (1:5)
- 100ml concentrated $H_2SO_4$+ 500 ml distilled water, and also need

- Deionized distilled water
- Nitric acid ($HNO_3$)- 1: 1
- Perchloric acid ($HClO_4$)
- Methyl red indicator
- 0.5gm. methyl red indicator+95%ethanol= Total volume will be 1 liter.
- 0.1N $AgNO_3$
- 17.04 gm. $AgNO_3$ is dissolved in 1lit distilled water.
- Ferric indicator

- 80 gm. of ammonium ferric sulfate $FeNH_4(SO_4)_2 \cdot 12H_2O$ in 1 lit distilled water.
- N $NH_4SCN$
- 7.613 gm. $NH_4SCN$ is dissolved in 1 lit distilled water.
- Two percent (2%) Potassium Chromate
- 2 gm. potassium chromate is dissolved in 100 ml distilled water.
- N NaCl
- 2.923 gm.dried NaCl is dissolved in 100 ml distilled water.
- 0.1 N Potassium Permanganate; $KMnO_4$
- 3.2 gm. potassium permanganate ($KMnO_4$) is dissolved in 1000 ml distilled water and after filter the solution is stored in dark bottle.
- 0.2 gm.dried sodium oxalate ($Na_2C_2O_4$) is taken into 500ml conical flask.
- 100 ml sulfuric acid; $H_2SO_4$ (1:5) is added to the conical flask and stirred until the solid dissolved.
- Then the solution is titrated with potassium permanganate ($KMnO_4$) until the solution turned pink.

**Sample Preparation Protocol**

- At least 2.5 kg fresh finished goods sample is collected from production line.
- The sample is taken into a fresh and new polythene bag
- The bag is shacked by hand (with feed sample) at air tight condition at least 200 times
- The sample is then grinded by 1mm sieve or blender can be used for grinding and then sieving by 1mm sieve.
- The sample is taken (after sieving by 1mm sieve) in a fresh polythene bag
- Again the bag is shacked by hand (with feed sample) at air tight condition at least 200 times
- Then the sample is packed (not more than 50 gm. in each pack) at air tight condition
- Proper label is added on the pack (Ex- Serial no., Feed Code, MF Date, PD Date etc.)
- The sample pack is storred in dry, cool and air tight condition
- One pack/month is used for analyzing several items. (%M, %Ca, %CP, %Salt etc.)

**NB:** Inert and fresh instrument and equipment are used for preparing sample to avoid contamination.

## RESULTS AND DISCUSSION

Nutrient values are varied according to the feed types and formulations. Nutritionist makes the feed formula depending on the bird types as well as age. Standard percentage of some majornutrient such as moisture, crude protein, calcium and salt values of different feed are represented in Table-1. Generally nutrient values are claimed depending on the formulation made by the nutritionist. Nutritionist fix the nutrient values according to the different bird and age of the bird. Nutrient values also depend on the proper grinding, mixing as well as proper production processing. Another factors are storage condition and time. Time is the important factor for storing the feed and nutrient values are directly related to this. Because there is a possibility to vitiate the nutrient values with time. For these reason we select two categories of feed (Broiler finisher and Layer finisher) for the stability study.

**Table 1. Standard nutrient values of different feed according to formulation**

| SL NO. | Feed Type | %M | %CP | %Ca | %Salt |
|---|---|---|---|---|---|
| 1 | Broiler Starter | 12.00 | 22.00 | 0.90 | 0.48 |
| 2 | Broiler Grower | 12.00 | 21.00 | 0.90 | 0.48 |
| 3 | Broiler Finisher | 12.00 | 20.50 | 0.85 | 0.45 |
| 4 | Layer Grower | 12.00 | 17.00 | 3.90 | 0.40 |
| 5 | Layer Finisher | 12.00 | 15.50 | 4.00 | 0.40 |

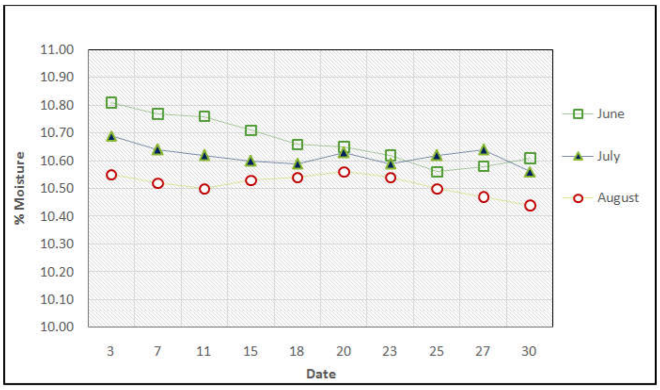


**Fig. 1. Moisture content of broiler finisher feed with date (Three month)**

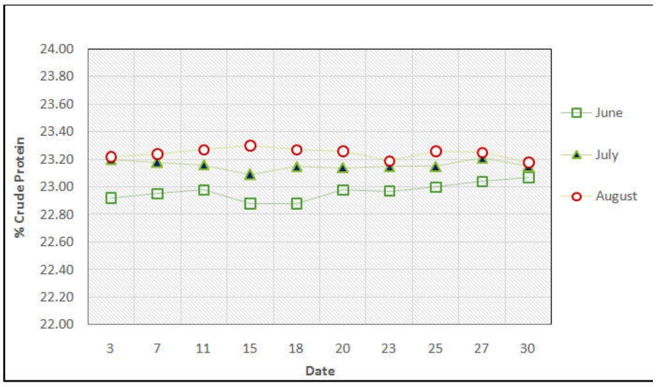


**Fig. 2. Crude protein content of broiler finisher feed with date (Three month)**

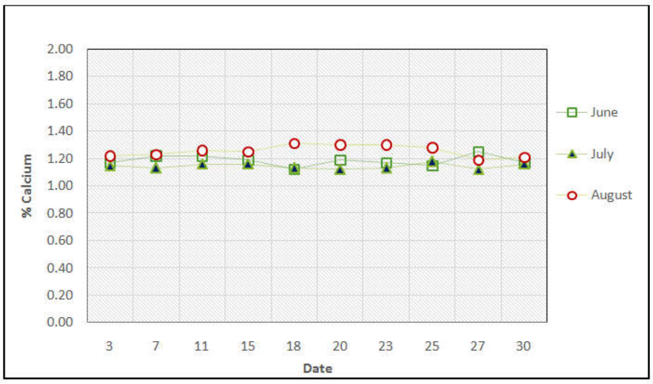


**Fig. 3. Calcium content of broiler finisher feed with date (Three month)**

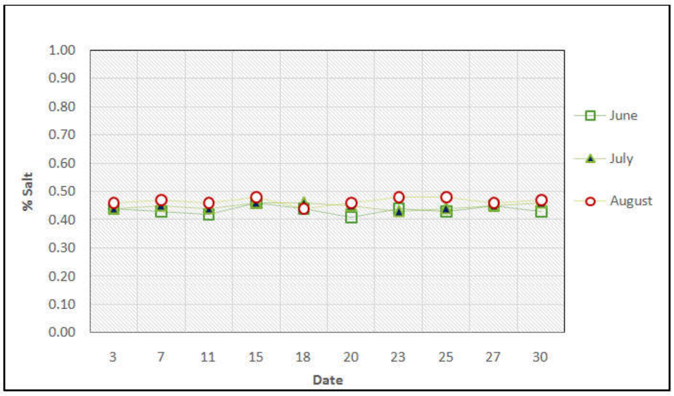


**Fig. 4. Salt content of broiler finisher feed with date (Three month)**

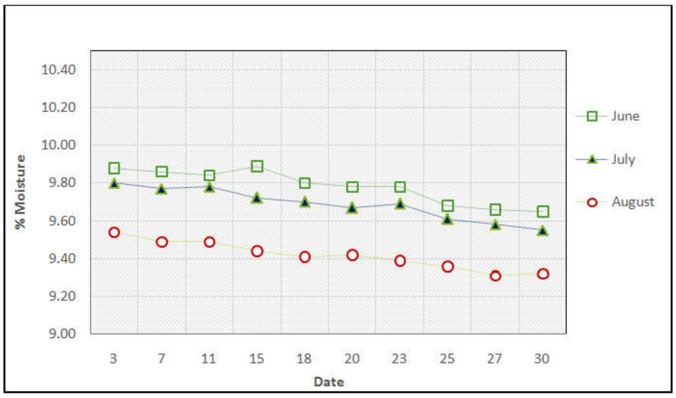


**Fig. 5. Moisture content of layer finisher feed with date (Three month)**

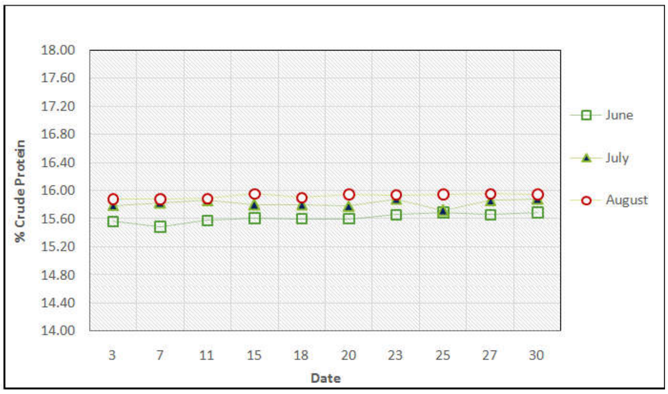


**Fig. 6. Crude protein content of layer finisher feed with date (Three month)**

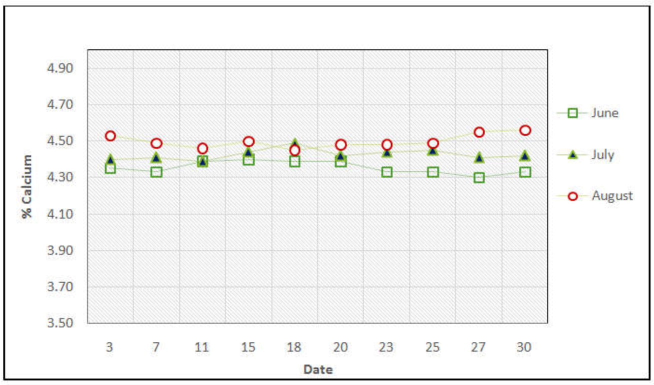


**Fig. 7. Calcium content of layer finisher feed with date (Three month)**

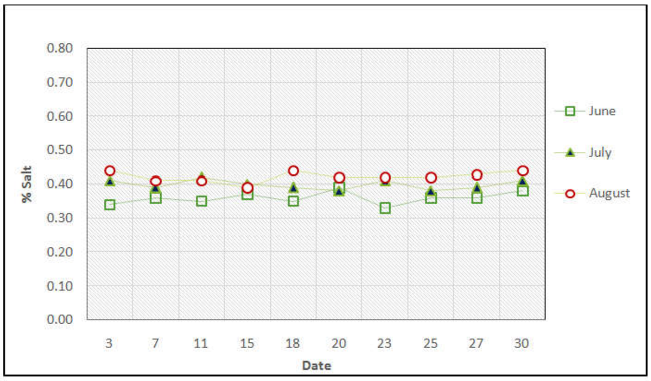


**Fig. 8. Salt content of layer finisher feed with date (Three month)**

## CONCLUSION

Feed nutrients level can be degraded with time and it also depend on the storage condition. We selected broiler finisher and layer finisher feed for the stability study. Moisture content all of these feed were slightly decreased with time and another nutrient such as protein, calcium and salt content were changed in the very much little amount. So it can be conclude that, after continuous observation and chemical analysis of the major nutrients within three month, there was no significant changes in the nutrient values under standard storage condition. Feed life time can be settled by this type of stability study.

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