Nutrient Requirement of Broilers

Broiler is a young chicken, usually 6-8 weeks of age, of either sex, that is tender meat with soft, palatable, smooth textured skin and flexible breastbone cartilage. There is need to obtain rapid growth in broilers. Ultimately nutrient requirements are also higher than the chickens being raised for egg production. In case of layer rate of growth is not important as they obtain a body weight of 1.5 kg in 20 weeks. The same weight is obtained in just 5-6 weeks in case of broiler.

Energy and protein requirements:

The accurate way to express the nutrient requirement is gram per kg of live weight, but in case of poultry group feeding is done so the nutrient requirement is expressed in terms of percent or per kg of ration, the CP requirement is expressed as CP percentage and energy expressed as ME kilo calorie /per kg of ration. In birds the unit of energy is kilo calorie or mega calorie the type of energy express is ME in words because it is easier to estimate the losses of energy through faeces and urine in combination. The reason is that there is a common opening for faecal and urinary losses called as cloaca and it is difficult to separately estimate the faecal losses only.

Enhancement of energy level of the diet in the finishing stage and simultaneously slight decrease in protein level causes the broiler to consume more calories that it can use for growth. It is partly because of slight deficiency of protein and partly because of high energy content of the diet. This excess energy will be converted into body fat, there by producing the desired body finish for the market broiler.

Estimation of energy requirement:

Several experiments have shown that 83 kcal of energy is required as BMR per kg metabolic size in in case of birds. Therefore, NE_m for a bird is 83 kcal/kg $W^{0.75}$. Experimental studies have shown that the NE requirement are approximately 18% lower than the ME requirement in poultry, which means ME_m = (83 kcal/kg $W^{0.75}$)/0.82. Total ME requirement for maintenance of bird = (83 kcal/kg $W^{0.75}$)/0.82 + activity increment. In deep litter system activity increment is 50% more and in cage system 37% more than ME_m.

Energy requirement for growth is the sum of calories of basal metabolism, activity increment and grown tissue.

ME requirement for growth in birds = (83 kcal/kg $W^{0.75}$)/0.82
+ {(83 kcal/kg $W^{0.75}$)/0.82} × 50/100
+ fat gain (g)/day × 9 kcal
+ protein gain (g)/day × 4 kcal

Fresh tissue of birds usually contains 18% protein and 15% fat.

Protein requirements for broiler:

The growth of the broilers depends up on the level of a balanced protein along with other nutrients. The need of the body for proteins is actually a need for the amino acid especially the essential amino acids. For our convenience instead of calculating the amino acid requirements, we calculate the protein requirement as it is easy to calculate.

The protein requirement of growing chicken includes the amount of protein needed for maintenance plus the amount needed for tissue growth with an allowance for the losses in the digestion and metabolism.

Calculation of protein requirement

- 61% of the total protein consumed is retained by the body of a growing chicken.
- Protein for maintenance requirement is **1.6 gm protein per kg body weight** i.e 250 mg N/ kg body weight.
- For tissue growth: As **muscle contains 18% protein,** protein requirement will be daily gain in g is multiplied by 0.18.
- For feather growth: Feather contains 82% protein and 7% of the body weight is feather. So, protein requirement will be daily gain in g × 0.07×0.82.
- Daily total protein requirement for a growing chicken will be:

(Body wt in kg×1.6g) + (daily gain in g×0.18) + (daily gain in g× 0.07×0.82)

This is actually retained protein (61%). So, actual intake will be:

$$= (\text{Body wt in kg} \times 1.6\text{g}) + (\text{daily gain in g} \times 0.18) + (\text{daily gain in g} \times 0.07 \times 0.82) \times \frac{100}{61}$$

Broiler chickens are more efficient in the utilization of dietary protein for growth (61-64%) than White Leghorn (55%). Hence the above formula can also be used for White Leghorn growing birds for calculating daily protein requirement by simply replacing 61% with 55%.

Amino acid requirement

The total protein requirement can be satisfied easily ,but in monogastric animal protein nutrition is actually amino acid nutrition so it is more importent to satisfied the requirement of amino acid rather tha the satisfying crude protein percentage .

There are generally ten essential amino acid for rate in poultry glycine and argentine rare additionally requires .Glycine is required because end product of metabolism of protein in bird is uric acid is not urea and biosynthesis of uric acid glycine is required. Glycine may be synthesised from keratin and serine as long as vitamin B12, folic acid and pyridoxine is not deficient.

Argenine is for poultry because it yields urea and ornithine, ornithine very essential because along with glycine it is required for the detoxification of aromatic compound in the liver.

Cysteine and tyrosine are semi essential because this amino acid can be obtained from methionine and phenyl alanine.

Limiting amino acid

Amino acids that are critical in the diet of poultry are arginine, threonine lysine methionine and tryptophan. Threonine tryptophan are only marginally deficient and careful selection of ingredient can avoid there deficiency. Argenine deficiency is not a problem if groundnut cake is used as ingredients.Lysine and methionine are the limiting amino acid in practical poultry diets, it is reported that methionine and lysine are first and second limiting amino acid in poultry ration.

The limiting amino acid concept may also be explained as follow the ratio between the amount of amino acid and its requirement gives an idea, the lowest ratio give the first limiting amino acid ,the next lowest ratio give the second most amino acid it has been reported that for poultry methionine is the only limiting amino acid in soya bean meal diets and if the diet contains sesame cake lysine is first limiting amino acid.

Lysine requirement as percentage of protein is less for egg production then for growth and deficiency in diet for egg production is not usual.

In general all the amino acid must be present in the diet at the same time for their efficient utilization, the needed amino acid can be supplemented in the practical diet. Synthetic L- lysine and D-L methionine are supplemented in the diet to make the diet animal protein free. Synthetic L- lysine and D-L methionine are available commercially at the reasonable price for poultry ration.

Amino acid toxicity

Methionine is the most growth repressing when add at 40 gm per kg diet , excess methionine depress the growth of chicks, excess of amino acid are also harmful because on excess amino acid may create an increased demand for another one for example toxicity of dietary lysine is overcome by increasing the level of argenine or glycine ,threonine eliminate the toxic effect of tryptophan, glycine reduce the toxic effect of methionine ,similarly the toxic effect of an excess luecine or valine are removed by isoleucine these are established interaction between amino acid and must be remembered when formulation the ration. Although the moderate excess may be allowed because it is not harmful.

Factors affecting amino acid requirement

1. Energy contents of diet - as the energy contents of diet increases the requirement of all the essential amino acid.
2. Content of polyunsaturated fat – because polyunsaturated fat upon peroxidation produce aldehydes which may bind lysine and thus make it unavailable.
3. Raw soybean causes hypertrophy of pancreas due to which there is more production of trypsinogen which is rich in methionine thus methionine requirement increases

Calorie protein ratio

It is defined as ME kcal /kg ration divided by % of CP in the ration. the ratio value varies with the age of birds calories protein ratio for BIS requirements are as fallow.

1. Broiler pre starter feed -130
2. Broiler starter feed -140
3. Broiler finisher feed-160

The calorie protein ratio is very important in all the animals for efficient utilization of feed. The important factor is as the energy density increase the intake of feed decrees and thus the CP % should we in the diet otherwise the animal will suffer from protein deficiency because of this reason while expressing the feeding standard along with energy and CP the calorie protein ratio should also be stated

Requirements of other nutrients

The maximum crude fibre (CF) and salt (NaCl) concentration in broiler diet should be 5% and 0.5%, respectively. Acid insoluble ash should not be more than 2.5% in broiler feeds. Higher intake of these components reduces feed utilization efficiency. Calcium (Ca) and total phosphorus (P) levels should be minimum 1% and 0.7%, respectively while available phosphorus is necessary to be minimum 0.45% in all types of broiler ration.

SUGGESTED NUTRIENT REQUIREMENTS FOR BROILERS (BIS' 2007)

Characteristic	Broiler Pre-starter	Broiler Starter	Broiler Finisher
Moisture, % (Max.)	11.00	11.00	11.00
Crude Protein, % (Min.)	**23.00**	**22.00**	**20.00**
Crude fibre, % (Max.)	5.00	5.00	5.00
Acid insoluble ash, % (Max.)	2.50	2.50	2.50
Salt, % (Max.)	0.50	0.50	0.50
Calcium, % (Min.)	1.0	1.0	1.0
Phosphorous (Available), % (Min.)	0.45	0.45	0.45
Linoleic Acid, % (Min.)	1.00	1.00	1.00
Lysine, % (Min.)	1.30	1.20	1.00
Methionine, % (Min.)	0.50	0.50	0.45
Meth. +cystine, %	0.90	0.90	0.85
Metabolizable Energy (Kcal/Kg) Min.	**3000**	**3100**	**3200**
Ether extract, % (min.)	3.0	3.5	4.0
Minerals and Vitamins:			
Manganese, mg/kg			
Iodine, mg/kg	100.00	100.00	100.00
Iron, mg/kg	1.20	1.20	1.20
Zinc, mg/kg	80.00	80.00	80.00
Copper, mg/kg	80.00	80.00	80.00
Selenium, mg/kg	12.00	12.00	12.00
Vitamin A, IU/Kg	**0.15**	**0.15**	**0.15**
Vitamin D_3, IU/Kg	6000	6000	6000
Thiamin, mg/kg	600	600	600
Riboflavin, mg/kg	5.00	5.00	5.00
Pantothenic acid, mg/kg	6.00	6.00	6.00
Nicotinic Acid, mg/kg	15.00	15.00	15.00
Biotin, mg/kg	70.00	70.00	70.00
Vitamin B_{12}, mg/kg	0.20	0.20	0.20
Folic Acid, mg/kg	0.015	0.015	0.015
Choline, mg/kg	1.00	1.00	1.00
Vitamin E, mg/kg	1400	1400	1000
Vitamin K, mg/kg	15.00	15.00	15.00
Pyridoxine mg/kg	1.00	1.00	1.00
	5.00	5.00	5.00

1. Earlier the broiler cycle was for eight week, it is now reduced to 6 week and starter periods are further split in to pre-starter 0-7 days and starter 8 -21days. Therefore it is advised that pre-starter feed to be used from 1-7 days. Starter feed 8-21 days and finisher feed from 22 days to finish.
2. An expected broiler performance as on current status is given, it must be noted that the performance parameter may change with the input of high genetic material in future, these values are applicable as on current basis and may be viewed as guidelines.

3. It has been observed that with the increasing usage of essential amino acid such as lysine and methionine the need of high protein has come down significantly, this has resulted in to lowering of protein content in the broiler feed lines.
4. Studies are being conducted on the role of threonine and tryptophan if they are available commercially to improve performance. The protein values can be changed in future.
5. The energy value has been increased as compared to existing Indian standards because of current feed efficiency 1.8 as compared to previous 2.2.
6. In earlier feeds use of methionine and choline was limited, this incorporation has gone up and since both help as lypolytic factors it is felt that role of biotin is limited hence the biotin value been reduced compared to existing Indian standard.

Nutrient Requirement of Layers

Layers are the birds which are reared for egg production these are the birds which have selectively breed for higher egg production (Normally 300 egg/ year). These birds are not reared for meat production and their growth is not very fast, thus requirements of protein and energy are comparatively lower then broiler the feeding of layer is generally done in three phases.

Estimation of Requirement for Egg Production

Nutrient requirement for egg production depends on production percentage (hen day production) and egg size. Good flock of layers produces an average of about 280-300 eggs per bird per year. Their eggs weigh an average of 55-57 g. Nutrient requirements for egg production include the nutrients required for maintenance and nutrients present in an egg.

Energy requirement

Energy requirement for egg production comprises the energy required for maintenance and energy present in an egg. Commonly the energy content of an egg is 86 kcal.

ME requirement for a laying bird = $(83 \text{ kcal/kg } W^{0.75})/0.82$
$+ \{(83 \text{ kcal/kg } W^{0.75})/0.82\} \times 50/100$
$+ 86 \text{ kcal}$

Protein requirement

The protein requirement for egg production can be determined by the factorial approach taking into consideration of maintenance requirement of protein to which protein content of egg is added. The maintenance requirement of protein in birds is generally 1.6 g/kg body weight/day. Average protein content of an egg is 6 g. Actual requirement of protein to be supplied in feed would be determined considering the efficiency of feed protein utilization as 55% in layer bird.

Calcium requirement

Calcium requirement of a layer is the sum of requirement of calcium for maintenance and calcium content in an egg. Average calcium content of an egg is 2 g. Actual requirement of calcium to be supplied in feed would be estimated considering the efficiency of feed calcium absorption as 40-50%.

The layer chicken is generally provided with four types of feeds throughout their cycle starting from day one (BIS, 2007):

1. **Chick feed for layer (CFL)**: A ration to be fed to chicks, intended for egg production, from 0 to 8 weeks.
2. **Grower feed for layer (GFL)**: A ration to be fed to growing chicken, intended for egg production, from 9 to 20 weeks or until laying commences.
3. **Layer feed for phase I (LFP-I)**: A ration to be fed to laying birds from 21 weeks to 45 weeks.

4. **Layer feed for phase II ((LFP-II)**: A ration to be fed to laying birds from 46 weeks to 72 weeks.

Phase I and II feeds in layer cycle are necessary because there are changes in production, egg size, requirement of calcium, efficiency of digestion, age, etc. as the cycle progresses.

Chick feed for layer contains 2800 kcal ME /kg and grower feed for layer contains 2500 kcal ME /kg. Followed by these, layer feed for phase I and layer feed for phase II contains 2600 kcal ME /kg and 2400 kcal ME /kg. Similar to the metabolizable energy requirement crude protein content is high (20%) in chick feed for layer and low (16%) in grower feed for layer as well as again high (18%) in layer feed for phase I and low (16%) in layer feed for phase II. Both the methionine and lysine requirements decrease with the age for layer birds with highest methionine level in chick feed for layer (0.4%) followed by grower feed for layer (0.35%), layer feed for phase I (0.35%) and layer feed for phase II (0.35%) and also similar for lysine level with the highest in chick feed for layer (1%) followed by grower feed for layer (0.7%), layer feed for phase I (0.7%) and layer feed for phase II (0.65%). However, calcium requirement for this type of birds is less upto pre-laying stage with the same calcium concentration in both the chick feed for layer (1%) and grower feed for layer (1%). As the laying starts as well as it continues, the requirement of calcium increases with layer feed for phase I containing 3% and layer feed for phase II containing 3.5% calcium.

SUGGESTED NUTRIENT REQUIREMENTS FOR LAYERS (BIS' 2007)

Characteristic	Chick Starter	Grower	Layer Phase I	Layer phase II
Moisture, % (Max.)	11.00	11.00	11.00	11.00
Crude Protein, % (Min.)	**20.00**	**16.00**	**18.00**	**16.00**
Crude fibre, % (Max.)	7.00	9.00	9.00	10.00
Acid insoluble ash, % (Max.)	4.00	4.00	4.00	4.50
Salt, % (Max.)				
Calcium, % (Min.)	0.50	0.50	0.50	0.50
Phosphorous (Available), % (Min.)	1.00	1.00	3.00	3.00
Linoleic Acid, % (Min.)	0.50	0.50	0.50	0.50
Lysine, % (Min.)	1.00	1.00	1.00	1.00
Methionine, % (Min.)	1.00	0.70	0.70	0.65
Meth. +cystine, %	0.45	0.35	0.35	0.30
Metabolizable Energy (Kcal ME/Kg) Min.	0.70	0.60	0.60	0.55
Ether extract, % (min.)	**2800**	**2500**	**2600**	**2400**
Minerals and Vitamins:	2.0	2.0	2.0	2.0
Manganese, mg/kg				
Iodine, mg/kg	90.00	50.00	55.00	55.00
Iron, mg/kg	1.00	1.00	1.00	1.00
Zinc, mg/kg	120.00	90.00	75.00	75.00
Copper, mg/kg	60.00	50.00	75.00	75.00
Vitamin A, IU/Kg	12.00	9.00	9.00	9.00
Vitamin D_3, IU/Kg	6000	6000	6000	6000
Thiamin, mg/kg	600	600	1200	1200
Riboflavin, mg/kg	5.00	3.00	3.00	3.00
Pantothenic acid, mg/kg	6.00	5.00	5.00	5.00
Nicotinic Acid, mg/kg	15.00	15.00	15.00	15.00
Biotin, mg/kg	70.00	60.00	60.00	60.00
Vitamin B_{12}, mg/kg	0.20	0.15	0.15	0.15
Folic Acid, mg/kg	0.015	0.10	0.10	0.10
Choline, mg/kg	1.00	0.50	0.50	0.50
Vitamin E, mg/kg	1300	900	800	800
Vitamin K, mg/kg	15.00	10.00	10.00	10.00
Pyridoxine, mg/kg	1.00	1.00	1.00	1.00
	5.00	5.00	5.00	5.00

1. In layer birds lying phase is divided in two phase. Phase-I (21-45 Weeks) and Phase-II (46-75 Weeks) because of change in production, egg size, requirement of calcium efficiency of digestion age etc.
2. Top dressing of extra calcium source in the form of shell grit/ limestone at about 4-5 gram per birds per day is advised in case of laying stage both in Phase-I and Phase-II.

3. The expected performance of layers has been furnished in table -9 which may be used as guideline depending upon the present genetic potential of birds.
4. it is advised to use chick feed from 0-4 week grower feed 5-22 week and layer breeder feed and male breeder feed from week 23 onwards.

Nutrient Requirements for Breeder

Effect of diet on egg hatchability

Hatchability is markly influenced by the composition of diet. The layer which are kept for breeding purpose must be supplied with a adequate ration consuming optimum CP and energy which are required by the layers in addition the conc. of some nutrients must be higher these are Mn, Fe, Zn, Cu, Vit E and B6 these play important role fertility and hatchability of the egg. The breeder birds should on low energy ration to avoid excessive fat deposition around the reproductive organs. The quality of protein is also very important for breeder birds.

Essential fatty acid (leinolic acid) is essential in the diet of breeder hens for the normal hatchability of egg.

- Riboflavin deficiency result in poor hatchability and cubed down embryo
- Biotin deficiency is reflected in parrot beaks
- Pantothenic acid deficiency shows unhatched embryo showing subcutaneous haemorrhage
- Thymine deficiency may result to early embryonic death high incidence of embryonic deformities
- Folic acid deficiency also leads to death of embryo during incubation
- Vitamin A, E, B12 are needed in proper amount to avoid early embryo mortality at around 2, 1-3 and 8-14 days respectively.

Mineral elements are essential for the development of embryo hence deficiency of minerals like Ca, P, Mn, Zn, Mg, Fe, Cu, Iodine, Mo and Se causes embryonic mortality and abnormalities. Similarly excess of Ca, P, and Se are also causes undesirable and depress hatchability.

Magnesium deficiency results in to condition known as nutritional chondrodystrophy or parrot beaks. This deficiency causes mortality of embryo around 18-21 days of incubation.

In case of Zn deficiency absence of legs and wings are observed in the embryo and feather down may appear tufted.