

Balancing Nutrient Levels: Meeting Specific Requirements for Different Poultry Groups

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Abstract

The nutrient composition of poultry diets is one of the major aspects that ensure high performance, productivity, and sustainability in poultry production. This study proposed evaluating the various nutritional requirements for various poultry types, such as broilers, layers, breeders, and turkeys, along with the impact of finished diets on growth performance, reproductive performance, and the quality of the finished products during production. In this research, a comparative analytical platform was used, where a total of 240 birds were evenly divided between the four types of poultry groups. In this study, the different formulated diets were used according to the physiology of the different groups of poultry, whereby the performance parameters of each diet were determined by the intake of the diets, weight gain, ratio of the diet: weight gain, egg laying, egg quality, fertility, and viability of the offspring. The evaluation of the research indicates varying capacities of the different types of poultry in using the different diet compositions. While the turkeys and broilers can effectively grow using diets high in energy and proteins, the layers need high calcium in the diets to ensure egg laying and quality. The breeders of the poultry indicate high fertility and viability using a diet formulated with proportional compositions of energy, proteins, and micro-nutrients. The present study indicates that the use of a diet formulated according to the types of poultry has an important effect on the productivity, efficiency of the used diets, and sustainability of the production processes.

Keywords. Poultry Nutrition, Nutrient Balance, Broilers, Laying Hens, Breeders, Feed Efficiency.

Introduction

The hen requires nutritionally balanced feed to meet her needs and ensure maximum productivity at a realistic cost. Due to age, genetic potential, and reasons for their rearing, along with their surroundings, these hens differ in nutritional requirements. Examples of such chickens are broilers, layers, breeder chickens, and turkeys. This calls for a tailored form of feed that is supplemented with defined proportions of energy, proteins, amino acids, vitamins, and micronutrients. Essentially, chicken nutrition seeks to facilitate maintenance functions, growth, reproduction functions, and other related activities such as improved egg traits or meat productivity. This is only possible through a clear comprehension of nutrient interactions and their influence on individual chicken groups [1].

Broiler chicken breeds, which are bred mainly for meat, have been known to display fast growth rates. For the fast growth to be achieved, broiler chicken feeds usually have high energy and protein content as well as essential amino acids like lysine and methionine in the right proportions. Energy from carbohydrates and lipids is required to meet the demands of metabolism and increase weight, while protein is essential for the development of muscles. But when energy is provided in surplus amounts without balancing the amounts of protein, then more body fat is produced as opposed to lean muscles. Thus, broiler chicken feeds have to be formulated in such a manner that fast growth is achieved without producing surplus amounts of fat in the bird, which affects the quality of the meat and makes it unmarketable [2].

On the other hand, nutritional needs for laying hens are geared towards supporting continuous egg production as compared to fast growth. The nutritional factor of most importance in layers involves adequate intake of the mineral elements, such as calcium and phosphorus, for producing the eggshell. Laying birds thus require a continuous intake of calcium, which, if insufficient, might lead to the production of thin eggshells and the breakage of eggshells. Second, for layers, nutritional requirements for protein and particular amino acids are needed for albumen production, as well as vitamin D3, which aids the release of calcium. Contrary to the nutritional needs for broilers, the layer nutritional diet requires moderate levels of both protein and energy. The layer diet, therefore, requires a nutritional diet rich in both nutrients and higher nutritional needs for supporting continuous egg production and eggshell quality throughout the entire egg production phase [3].

Breeder chickens, whether meat or egg breeders, involve yet another set of nutritional issues. Breeders have to provide fertile eggs that give rise to healthy chicks, and this would mean that nutrition has to meet not only body condition but also facilitate the process of egg reproduction. The nutrient balance in breeder diets affects the fertilization of eggs, the rate of hatching, and the overall health of chicks. Some nutrients, such as trace elements and vitamins, are vital nutrients that play a very important role in the reproductive process of eggs and embryo development. Overnutrition results in breeders exhibiting excessive weight with poor fertility rates, while nutritional deficiencies can inhibit hatching rates. Thus, breeder diets have to be very precisely formulated to maintain optimum body condition scores, and the embryo's required nutrients need to be passed with ease. [4].

These birds are reared for meat; however, due to their size and slower growth rates, their nutritional formulae also differ from those of broilers. In any case, turkeys require high and exact levels of amino acids and protein to allow the development of muscles, mainly around the breast and thigh portions. Additionally, turkeys are known to be sensitive to nutrient imbalance levels, like calcium, that could affect their bone strength and overall health. Younger turkeys, called poults, demand different nutrient requirements, differing from those that are already destined for the market, and hence the need for phase feeding formulations that vary the levels depending on the development levels of the turkeys. All poultry, including turkeys, broilers, and others, demand essential nutrient levels like vitamins and trace minerals, which are fundamental components involved in the metabolic processes, the immune system, and the development processes, respectively. Excess or deficiency may lead to decreased productivity and profit margins due to reduced health and increased susceptibility to disease [5].

This research work aims to investigate, evaluate, and optimize nutrient level ratios in the different categories of poultry, such as broilers, layers, breeders, and turkeys, for their various physiological activities, goals, and health aspects throughout different growth stages. This research work tries to find the prominent nutritional aspects among various categories of poultry, as well as the impacts of formulated nutrition on improving productivity, efficiency, reproductive capability, and output effectiveness in an effective manner by avoiding waste related to nutritional aspects. This project is novel in its comprehensive nature, including the analysis of different categories of poultry in the same study, instead of limiting the study to a particular form of poultry. By properly incorporating the principles of nutritional aspects into the different stages of growth and specific feeding for various functions, this project provides up-to-date information for effective poultry nutrition practices.

Literature Review

The theoretical foundation for the above study is grounded in the species- and function-dependent nutrition principle, which indicates the nutrient requirements dependent upon the physiological status, growth phase, and production goals for animals. For example, in poultry production, the use of different nutrients like energy, protein, amino acids, vitamins, and minerals does not occur simultaneously in different poultry species. On the contrary, this is dependent upon the metabolic priorities of the nutrients, which include categories such as maintenance, growth, reproduction, and the production of meat and eggs. Poultry nutrition theories require a balanced diet to be achieved to prevent any adverse effects in relation to performance and cost [6].

Another important theoretical basis is the nutrient partitioning theory, which describes the way that poultry allocate nutrients from the consumed diet for different functions. For growth-oriented fowl, such as broilers and young turkeys, the main nutrient partitioning function is accrual, leading to a greater need for ME and amino acids. In bred fowl, like layers and egg-type breeders, nutrient partitioning functions, such as egg production, eggshells, and embryos, require a higher intake of minerals and vitamins, particularly those that are fat-soluble, such as Ca, P, and Fat-Soluble Vitamins. Each flock will respond differently to the efficiency of nutrient delivery for desired growth rates and efficiencies [7].

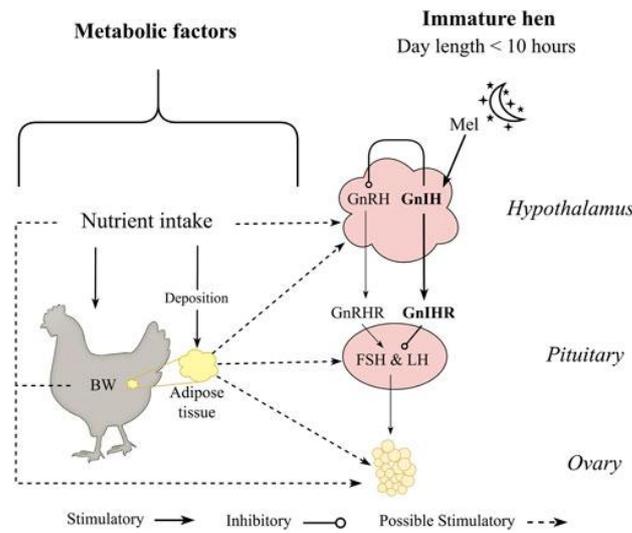


Figure 1. Metabolic factors of Hen [8].

The puberty in pullets held in non-stimulatory photoperiod conditions has been believed to be affected by metabolic factors (Figure 1). GnIH plays a major role in the release of the neuropeptide from the hypothalamus in response to melatonin, Mel, produced by the pineal gland in pullets held under photoperiod conditions equal to or less than 10 hours. By inhibiting the FSH-LH axis, GnIH/GnIHR in the anterior pituitary gland holds the bird in the young or immature state. It is believed that nutritional status and carcass fat mass influence the pullet-to-hen transition period, induced without photostimulation, at least regarding a photoperiod being above, or equal to 12 hours. [8].

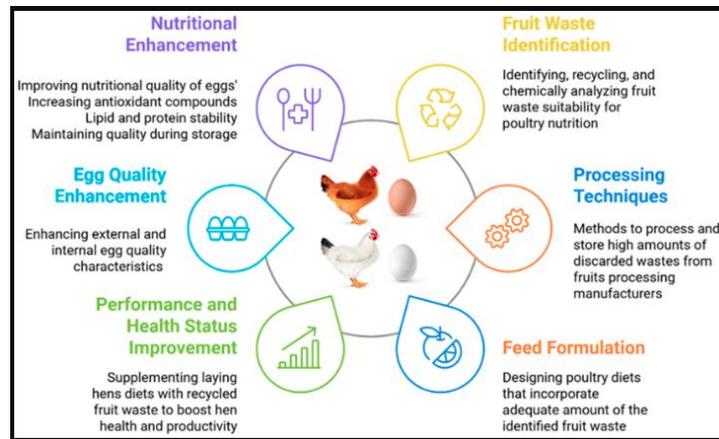


Figure 2. Graphical representation of the benefits of fruit waste in laying hens' nutrition [9].

Furthermore, balanced ration formulation serves as another theoretical underpinning of this research study. This theory concentrates on achieving peak productivity rather than maximizing a singular nutrient criterion, but rather a planned mixture of certain nutrients like energy to proteins, calcium to phosphorus, etc. That is only possible when this balance is maintained among nutrients. Hence, this theoretical formulation is an important underpinning of this research study that justifies the need for precise nutritional approaches being adopted in a contemporary chicken rearing system [6]. Nutritional interventions involving natural antioxidants from natural plant sources can thus provide an effective solution to the deteriorating albumin quality over a period of time when stored, as there won't be an adverse health effect posed to consumers. The probable implications of employing fruit waste as a supplementary diet of laying hens are pictorially represented in (Figure 2) [9].

Materials and Methods

Study design and sampling

A comparative and analytical type of research design was used in the study. The design compared the nutrient requirements among different types of poultry, such as broilers, layers, breeders, and turkeys. The method utilized both structured feed experiments and secondary data analysis. The study sampled the population through purposive sampling. The method involves selecting representative poultry groups based on their intended use and age. The poultry groups were categorized according to standard poultry development levels (starter, grower, finisher, or production phase). The different feed formulations were prepared according to standard nutrient guides. The poultry groups were given feed formulations according to their intended objectives.

In this study, 240 birds were used, which consisted of four treatments, depending on the type and function. Therefore, the population being studied was 60 broilers, 60 layers, 60 breed chickens, and 60 turkeys. Amongst each treatment category, birds were divided according to their relevant stage and kept under consistent management practices. The sample population was deemed representative for demonstrating variance in nutritional demands and performance criteria amongst each type of bird, and was sufficient for statistical interpretations and research findings.

Data collection

Data collection was both primary and secondary [10]. Primary data was collected through controlled observations conducted on poultry performance criteria, such as feeding rate, weight gain, and the feed conversion ratio, rate of egg production, rate of egg quality measurements, fertility, and hatchability (for breeding strains). Feed nutrient content was subject to standard proximate analysis to obtain the content of crude protein, metabolizable energy, essential amino acids, minerals, and vitamins. Secondary data was compiled from peer-reviewed journals, nutrient requirement documents, and industry literature to supplement and affirm the results arrived at. Environment and management variables like facility, temperature, and health conditions were noted to ensure that external influences are not related to the result variables.

Data analysis

The analysis of the data used descriptive and comparative statistical methods (SPSS). The means and standard deviations were used to describe nutrient intake and performance variables for trend analysis among poultry breeds [11]. Comparative statistical techniques were employed for the analysis of discrepancies in nutrient efficiency and production performance among the different poultry breeds. When appropriate, analysis of variance was utilized for the determination of statistically significant variations in performance variables due to differences in nutrient levels. The results of the study were interpreted against established nutritional requirements for the effectiveness and adequacy of nutrient-balancing strategies. Through this method of analysis, systematic variations and efficiencies influenced by specially designed nutrient compositions among different poultry production systems could be effectively assessed.

Results

The experiment utilized a total of 240 birds, distributed proportionately depending on their type and production targets. (Table 1) represents the major constituents of the formulated feed preparations based on the various birds qualified as broilers, layers, breeders, and turkeys. The following criteria represent requirements relating to energy, protein, essential amino acids, and major minerals in line with the target and physiological needs of the different chicken groups.

Table 1 shows that there are distinct differences in nutritional needs among the poultry categories. Broilers and turkeys have higher protein and ME needs for prolific muscle growth. On the other hand, layers and breeders need more calcium for deposition in the production of eggshells and for their reproductive activity. These divergent needs further underscore that poultry feeds, of necessity, have to be special for different specific purposes so as not to create imbalance in their performance. (Table 2) presents the growth rate of broiler poultry, including broilers and turkeys, represented through their daily feed consumption, body gain, and feed conversion ratio.

Table 1. Nutrient Composition of Experimental Diets for Different Poultry Groups

Poultry Group	Metabolizable Energy (kcal/kg)	Crude Protein (%)	Lysine (%)	Methionine (%)	Calcium (%)	Phosphorus (%)
Broilers	3,100	22.0	1.30	0.50	1.00	0.45
Layers	2,750	18.0	0.90	0.40	4.00	0.50
Breeders	2,800	16.5	0.85	0.38	3.20	0.45
Turkeys	3,000	24.0	1.40	0.55	1.20	0.50

From the data presented in Table 2, it can be seen that there are considerable differences in feed intake, growth rate, and feed conversion efficiency among these groups of poultry, depending on their respective purposes of production and their genetic backgrounds. Among these groups, broilers showed the highest feed conversion efficiency with the lowest value of FCR, i.e., 1.69. This indicates that broilers have a better ability to utilize feed for growth than turkeys, layers, and breeders. Although turkeys showed higher feed intake (145 g/bird/day) and higher weight gain per day than broilers, i.e., 75 g/bird/day, their FCR value, i.e., 1.93, indicates that they are less efficient than broilers. Moreover, layers and breeders showed very low weight gain and high values of FCR, i.e., 2.10 and 2.25, respectively, because their nutrient requirements are mostly used for egg production, reproductive activity, and maintenance rather than growth. These results clearly indicate that it is essential to adjust the feeding strategies and nutrient formulations according to the physiological activity and performance of each group of poultry to optimize their productivity and efficiency. The parameters of egg production in laying hens, including the characteristics of the eggshells, are provided in (Table 3).

Table 2. Growth Performance of Different Poultry Groups

Poultry Group	Average Daily Feed Intake (g/bird/day)	Average Daily Weight Gain (g/day)	Feed Conversion Ratio (FCR)
Broilers	110	65	1.69
Turkeys	145	75	1.93
Layers	115	12	2.10
Breeders	120	15	2.25

The findings in Table 3 show that a balanced diet of nutrients, including protein and calcium, is associated with the laying of quality eggs in large quantities and good quality shells. Optimum laying of eggs with no damage to the shells would mean indications of the birds' optimal nutrient requirements. The following table represents the reproductive success by fertility, hatchability, and chick weight at hatch.

Table 3. Production Performance of Laying Hens

Parameter	Mean Value
Feed Intake (g/hen/day)	115
Egg Production Rate (%)	90.2
Average Egg Weight (g)	62.5
Eggshell Thickness (mm)	0.36
Eggshell Breakage (%)	3.8

It is evident from Table 4 that a proper nutrient balance has contributed much to the improvement of breeder reproductive performance. High fertilization and hatchability rates mean that optimum embryonic development has been facilitated by nutrient intake, vitamins, and microminerals. Good hatchability also means that effective nutrient transfer from the mother into the egg may have helped in improving chick quality in the early growing stages. Table 5 shows the percentage efficiency of protein and energy utilization across different poultry groups as an indication of effectiveness in feed formulation.

Table 4. Reproductive Performance of Breeder Poultry

Parameter	Mean Value
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Feed Intake (g/bird/day)	125
Egg Fertility (%)	92.0
Hatchability (%)	88.5
Chick Hatch Weight (g)	42.0

Results in Table 5 show that meat birds, especially turkeys and broilers, have relatively higher levels of protein and energy utilization efficiency compared to layers and breeders. This can be attributed to the fact that meat birds require higher deposits of muscular tissue, while layers and breeders require deposition of nutrients for reproductive and egg production activities. Results have ensured that nutritional needs, in terms of differences in amounts and uses, require specific nutritional approaches aimed at different groups.

Table 5. Comparative Nutrient Utilization Efficiency Across Poultry Groups

Poultry Group	Protein Utilization Efficiency (%)	Energy Utilization Efficiency (%)
Broilers	68.5	72.0
Layers	65.0	70.3
Breeders	63.8	68.9
Turkeys	70.2	73.5

Discussion

As shown by the statistics, broilers, layers, breeders, and turkeys all have somewhat different requirements according to their specific needs; therefore, several breeds need different feeding methods. Growth rate, productive functions, and production objectives obviously determine nutrient intake. It is very crucial in this sector to have an appropriate diet composition so as to maximize output and minimize wastage. For broiler chickens, the results have shown that higher metabolizable energy and protein concentrations work well for supporting fast growth and optimal FCRs. The fact that the FCR for broilers remained fairly low is an indication of their efficient muscle accumulation capacity, as these birds were bred for their aptitude in utilizing available nutrients for growth, considering that their dietary amino acid patterns were appropriately balanced. Apparently, adequate dietary lysine and methionine supplies are critical to optimal lean tissue growth since, as will be discussed below, poultry nutrition [12].

For turkeys, despite the need for high protein and energy, there was a slight reduction in the efficiency of feed utilization compared to broilers. The rationale behind this may be linked to the metabolic needs and growth patterns of turkeys in comparison to other domesticated poultry species. It has been established that turkeys have higher feed intake levels owing to the size of the birds and the physiological needs of the species, including the development of the skeleton as well as the prevention of leg problems. However, as the duration of the test as well as the age of the birds was not well specified in the methodology, the differences in the efficiency of the feed as seen in the research should be viewed critically. The above results emphasize the use of phase-feeding practices for turkeys, as their nutritional densities change according to their needs, which would improve their efficiency of nutritional use over time [13].

Results obtained on layer performance confirm the importance of mineral balance, particularly calcium and phosphorus, in maintaining high egg production rates and quality eggshells. The high record of egg production and low breakages recorded in the experiment confirm that adequate amounts of calcium were supplied in the diets to handle the day-to-day demands of eggshell production. On top of this, supplementation with proteins and amino acids was instrumental in ensuring satisfactory egg weights and albumen quality. These effects confirm an important shift in layer nutrition from growth to functionality and quality, thus requiring consistency in nutrient delivery. Any imbalance in calcium or vitamin D may have adverse effects on eggshell quality and layer performance [14], but high fertility and hatchability percentages in breeder chickens indicate proper reproductive function.

The importance of nutrient balancing not only to breeder's physique but also to embryo and chick development is thus evident. Micronutrient adequacy, including trace elements and fat-soluble vitamins, would appear to be instrumental in improved reproductive function. Overnutrition is recognized as impairing breeder fertility, while

reproductive and embryo trouble can result from inadequate nutrition. The findings of this study support precision poultry nutrition of breeders for maximum reproductive effectiveness and improved chick quality [15].

The comparison of nutrient utilization efficiency can also show additional functional differences within the poultry types. The protein and energy utilization efficiency of broilers and turkeys was found to be more efficient due to their metabolic emphasis being primarily focused on the process of growth. However, for layers and breeders, the efficiency was found to be marginally less, which can be attributed to their energy being directed towards the production of eggs instead of their body weight gain. The emphasis here should thus remain within the framework of understanding production objectives instead of just measuring performance. The less efficient utilization of nutrients in layers, for instance, can thus instead depict the utilization of nutrients in other productive ways, such as the production of eggs [16].

Management-wise, it is clear that the study emphasizes that customized nutrition is beneficial from an economic and environmental perspective. Formulating a diet that is quite akin to the needs of a particular group of poultry can aid in decreasing feed costs, optimizing productivity, and curtailing nutrient leakage that adversely affects environment health. An overabundance of proteins and minerals raises feed costs and leads to environmental pollution owing to excessive nitrogen/phosphorus outputs [17].

However, the observations made by this study also hold important implications for small- to medium-scale broiler rearing, where normalized feeding methods are utilized due to a lack of technological aid. As has been discussed in the current study, even the most minute changes made on the basis of the type of poultry being raised can help realize important improvements in the process. This, in turn, underscores the importance of nutrition-related learning initiatives by extension specialists to promote sound feeding methods for different rearing systems. However, there also lie some limitations to this study. As already discussed, the observation period for this study only considered particular stages of this process, which may need to be observed for an interval extending beyond this period if the long-term performance of the process, apart from its health aspects, needs to be determined. Moreover, the effect of other conditions, like the surrounding temperatures, may also affect the use of nutrients despite being properly controlled, as confirmed by a study in [18].

Future studies might seek to investigate the role of nutrition, genetics, and management practices, and also alternate ingredients and precision feeding systems, for enhancing nutrient use efficiency further. Providing nutrients according to the nutrient specifications of the respective groups of poultry is the key to getting optimal production performance. The findings of this experiment support that proper nutrition can enhance growth, reproduction, and product quality characteristics, and also nutrient use efficiency. With the use of stage and group-specific nutrition, the poultry farmer can provide nutrients according to the body requirements of the poultry, and hence efficient and profitable poultry production [19].

Conclusion

In light of this study, there is a necessity to take proper measures of nutrient requirements of different groups of poultry with their distinct physiological requirements and purposes of production. The results of the study showed that nutritional balances of different groups of chickens, including broilers, layers, breeders, and turkeys, were different regarding their requirements for energy, proteins, amino acids, and minerals. Where the poultry raised for reproduction and laying eggs required careful mineral balance and nutrient intake, such as layers and breeders, the poultry being raised for development required high energy and proteinous diets for higher feed conversion and growth rates, including broilers and turkeys. The differences and similarities among the various dietary needs form the foundation of nutrition that differs among birds and impact general development, health, and production.

Based on the findings of the present work, it has been suggested that instead of using common feed formulation diets in poultry farming, feeding strategies based on groups and phases are considered. Feed formulation should be altered periodically according to changes in age groups, stages of farming, as well as according to the physiological requirement, keeping in mind the E/P ratios as well as critical elements like Ca and P. Moreover, there should be constant evaluation of feed quality in terms of its performance to estimate its sufficiency as a dietary requirement. In addition, it has been suggested to conduct future work on the long-term effects of precision nutrition, the utilization of different feedstuffs, and precision feeding technology integration.

Conflict of interest. Nil

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