OPTIMIZING NUTRITION OF MODERN BROILERS

Key Considerations for Diet Formulation and Feed Manufacturing

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INTRODUCTION

A key element in achieving optimal performance in broiler chickens is genetic improvement. Investments in technology, infrastructure, and human capital in the pedigree improvement programs allow the delivery of continuous and consistent optimal growth rates, feed efficiency, meat quality, and welfare at the broiler level. Environment, management, health, and nutrition considerations are also crucial to the success of commercial production to realize the birds' full genetic potential.

When considering nutrition's role in the management of the ever-changing and improving broiler, balanced protein (BP) and feed texture are vital features. Along with affecting productivity, inadequate BP may also strongly affect economic profitability due to potential negative effects on feed intake, feed conversion, growth rate, and carcass traits. Another important consideration beyond the nutrient profile of the diet is feed texture. Adequate BP and appropriate feed form and particle size are all vital to achieving optimal performance goals.

FORMULATION OF BALANCED PROTEIN

Balanced Protein

The formulation process for broiler chickens accepts the concept of BP, which means that a set of digestible essential amino acids (dEAAs) are accounted for in relation to digestible lysine (dLys). By using the BP profile, nutritionists can modify the protein supply while maintaining the same ratio of amino acids across various production situations and market conditions. The BP profile recommended by Aviagen® (**Table 1**) results from meticulous experimental and field research; therefore, it should be a standard practice to achieve good biological performance of broilers.

Table 1. Balanced protein profile for broilers.*

		AGE FED - days				
		0-10	11-24	25-39	40-51	>52
Lysine	%	100	100	100	100	100
Methionine + Cyst(e)ine	%	76	78	80	80	80
Methionine	%	42	43	44	44	44
Threonine	%	67	67	67	67	67
Valine	%	76	77	78	78	80
Isoleucine	%	67	68	69	69	70
Arginine	%	106	108	108	110	112
Tryptophan	%	16	16	16	16	16
Leucine	%	110	110	110	110	110

*Aviagen Broiler Nutrition Specifications, 2022.

Modern broilers are very responsive to BP, which is the main driver for obtaining optimal performance. Therefore, follow the recommended dLys and dEAAs–dLys ratios during the formulation process; this is essential for broilers to optimize protein utilization and achieve the performance objectives for growth, feed efficiency, and carcass yield components. Adequate BP is achieved by using a variety of vegetable or animal protein sources and synthetic amino acids. There are currently many different synthetic amino acids available for broiler feeds in addition to methionine, lysine, threonine, and tryptophan, such as valine, isoleucine, arginine, and histidine, among others.

Table 2 shows broiler corn-based diets resulting from a formulation exercise without alternative raw materials and with and without L-Valine, L-Arginine, and L-Isoleucine. In general, when formulating a diet using conventional ingredients without alternative raw materials, the supplementation of these synthetic amino acids is necessary to obtain optimal BP; otherwise, suboptimal levels of any specific essential amino acid may result in an imbalanced amino acid profile, which can compromise performance. If these synthetic amino acids and alternative raw materials are unavailable, the least-cost formulation system attempts to achieve their lower limits by adopting intact protein from other ingredients. As a result, crude protein (CP%) might be increased to comply with the recommended BP. Higher CP% might result in increased soybean meal inclusion in the diets and subsequent potential risks, namely gut health issues and poor litter quality, which are detrimental to animal health and welfare. In the case of non-availability of L-Valine, L-Arginine and L-Isoleucine, the use of alternative raw material sources of protein (e.g., sunflower meal, canola meal, peas, potato protein, distiller's dried grains with solubles [DDGS] corn, etc.), may help to reduce CP% and thus the reliance on soybean meal (see **Table 3**).

Table 2. Broiler corn-based diets resulting from a formulation exercise with and without L-Valine, L-Arginine and L-Isoleucine, and without alternative raw materials.

Corn-Soybean Meal-Based Diets							
Component	**Unit**	**Starter**		**Grower**		**Finisher**	
Sunflower Meal	%	0	0	0	0	0	0
DDGS Corn	%	0	0	0	0	0	0
Canola Meal	%	0	0	0	0	0	0
Potato Protein	%	0	0	0	0	0	0
Peas	%	0	0	0	0	0	0
L-Valine	%	**0.063**	**0**	**0.028**	**0**	**0.043**	**0**
L-Arginine	%	**0.035**	**0**	**0.003**	**0**	**0.051**	**0**
L-Isoleucine	%	**0.020**	**0**	**0**	**0**	**0.033**	**0**
Energy per Kg (WPSA)	kcal	2975	2975	3050	3050	3100	3100
Crude Protein	%	23.0	24.3	21.5	22.1	19.5	20.4
Digestible Amino Acids							
Lysine	%	1.32	1.32	1.18	1.18	1.08	1.08
Methionine	%	0.66	0.65	0.60	0.59	0.55	0.54
Methionine + Cyst(e)ine	%	1.00	1.00	0.92	0.92	0.86	0.86
Threonine	%	0.88	0.88	0.79	0.79	0.72	0.72
Tryptophan	%	0.27	0.29	0.25	0.26	0.23	0.24
Isoleucine	%	0.88	0.92	0.80	0.83	0.75	0.76
Leucine	%	1.57	1.67	1.49	1.54	1.36	1.43
Valine	%	1.00	1.00	0.91	0.91	0.84	0.84
Arginine	%	1.40	1.47	1.27	1.31	1.17	1.20

Table 3. Broiler corn-based diets resulting from a formulation exercise without L-Valine, L-Arginine and L-Isoleucine, and with and without alternative raw materials.

Corn-Soybean Meal-Based Diets							
Component	**Unit**	**Starter**		**Grower**		**Finisher**	
Sunflower Meal	%	**0**	**5.000**	**0**	**8.000**	**0**	**10.000**
Peas	%	**0**	**5.000**	**0**	**10.000**	**0**	**10.000**
Potato Protein	%	**0**	**2.364**	**0**	**1.988**	**0**	**2.647**
DDGS Corn	%	**0**	**0.306**	**0**	**4.673**	**0**	**0.151**
L-Valine	%	0	0	0	0	0	0
L-Isoleucine	%	0	0	0	0	0	0
L-Arginine	%	0	0	0	0	0	0
Energy per Kg (WPSA)	kcal	2975	2975	3050	3050	3100	3100
Crude Protein	%	24.3	23.4	22.1	21.5	20.4	19.7
Digestible Amino Acids							
Lysine	%	1.32	1.32	1.18	1.18	1.08	1.08
Methionine	%	0.65	0.66	0.59	0.60	0.54	0.55
Methionine + Cyst(e)ine	%	1.00	1.00	0.92	0.92	0.86	0.86
Threonine	%	0.88	0.88	0.79	0.79	0.72	0.72
Tryptophan	%	0.29	0.27	0.26	0.24	0.24	0.22
Isoleucine	%	0.92	0.90	0.83	0.81	0.76	0.75
Leucine	%	1.67	1.65	1.54	1.53	1.43	1.41
Valine	%	1.00	1.00	0.91	0.91	0.84	0.86
Arginine	%	1.47	1.40	1.31	1.27	1.20	1.17

Influence of Feed Texture

The growth rate of broilers increases over time. As a result, the first week of life is important in relation to the total growth cycle. The first few days of life involve rapid development of the gastrointestinal, immune, and cardiovascular systems, along with skeletal growth and feather coverage. Therefore, it is essential to supply the birds with the energy and nutrients to meet their requirements and obtain optimal first-week performance. To achieve this, consider the appropriate feed form and particle size to maximize early feed intake.

Feed Form and Particle Size

In general, sieved crumble or mini-pellets are adequate in the Starter period (up to 10 days of age), maximizing particles close to 2 mm in size, which the chicks prefer. The 11–18-day period should transition smoothly from sieved crumble or mini-pellets to pellets; as such, mini-pellets (longer than those of the Starter period), coarse crumble, or short-cut pellets are suitable feed forms, maximizing particles close to 3 mm in size, which the birds prefer in this interval. After 19 days, pellets are the preferable feed form, mainly with particles above 3 mm in size. Further details on feed textures are provided in **Table 4.**

It is essential to minimize fine particles in the feeders across all the diets, with no more than 10% below 1 mm. Research shows that every 10% increase in fine particles (<1 mm) results in a reduction of 40 g (0.09 lb) in body weight at 35 days. Therefore, good crumble/pellet quality is essential. Poor crumbles or poor pellets may result in reduced feed intake, leading to a reduction in biological performance. Additionally, pay close attention on the farm to manage feed distribution to minimize physical deterioration of crumble and pellets.

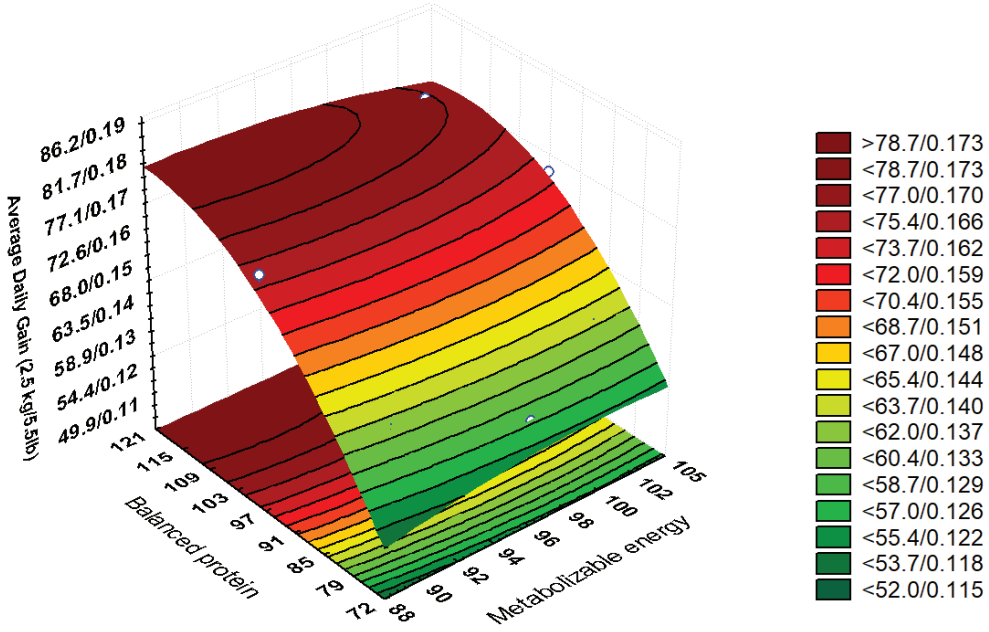
Table 4. **Feed form and recommended particle size by age in broilers.**

Age	Feed Type	Feed Form and Size
0-10 days	Starter	Sieved crumble 1.5-3.0 mm diameter or Mini-pellets 1.6-2.4 mm diameter 1.5-3.0 mm length
11-18 days	Grower (This is normally the first delivery of grower feed.)	Mini-pellets 1.6-2.4 mm diameter 4.0-7.0 mm length
19-24 days	Grower	Pellets 3.0-4.0 mm diameter 5.0-8.0 mm length
24 days to processing	Finisher	Pellets 3.0-4.0 mm diameter 5.0-8.0 mm length

Crumbled and pelleted feed forms have important advantages compared to mash presentation. These include increased feed intake, elimination of feed segregation and selective feeding, reduced feed wastage, and reduced energy expenditure associated with feeding. Pelleting, however, is a costly step in feed manufacturing, so mash feeding is becoming increasingly more attractive.

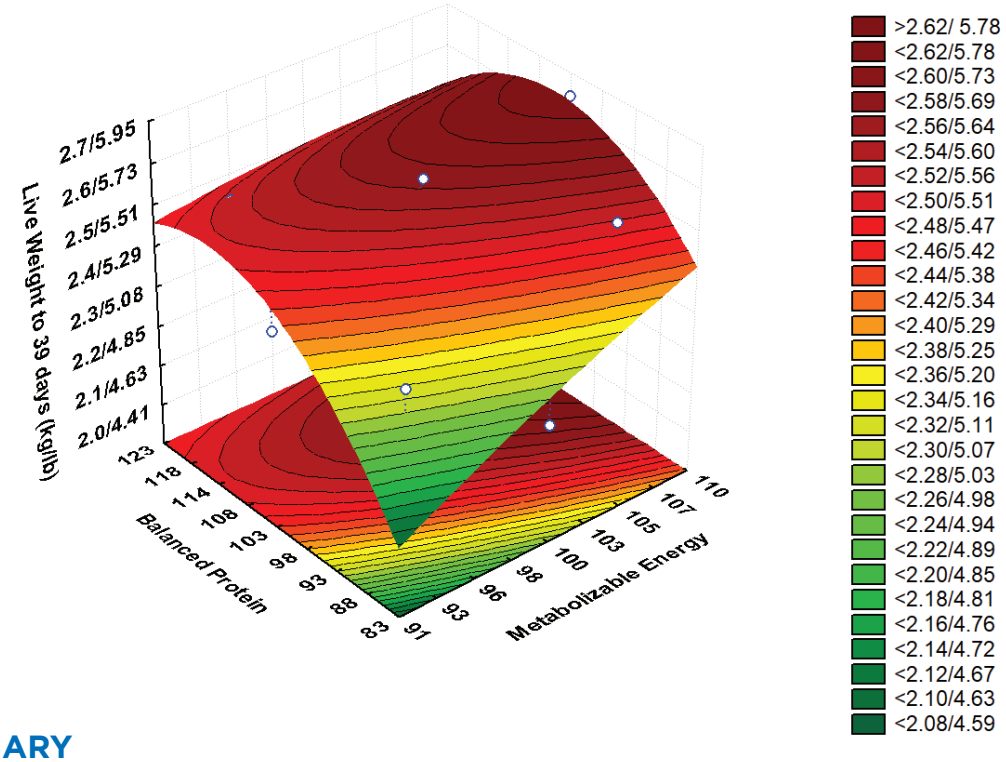
To appropriately assess the pros and cons of pellet and mash feeding, additional market considerations should be kept in mind. Due to volatile, unpredictable markets and high input costs (e.g., raw materials, fuel, and labor), broiler producers are looking for cost-saving opportunities. **Figure 1** shows that broiler performance (average daily gain [g] of male broilers to 2.5 kg) is more responsive to BP than metabolizable energy (ME). In fact, BP is the primary component in the formulation driving the performance of modern broilers; therefore, depending on company targets and the current market situation, savings opportunities might be found in reducing ME and increasing BP. However, the responses of pellet and mash presentations to different ME levels should be considered.

Figure 1. **Average daily gain (g) of male broilers to 2.5 kg in response to varying levels of ME and BP (expressed as digestible lysine level). The 100% ME and BP treatment group is referencing Aviagen's recommendations.**



Regarding live weight (kg) in broilers fed mash, Aviagen's internal research reports a significant response to different ME levels. In particular, ME below Aviagen's recommendation significantly reduces live weight. **Figure 2** shows an example with 39-day-old birds. The same research with broilers fed pellets does not report a response to different ME levels; specifically, ME below and above Aviagen's recommendation does not significantly affect live weight. Therefore, unlike mash presentation, feeding pellets reasonably below Aviagen's ME recommendation does not reduce the biological response of the birds, most likely resulting in a cost-saving opportunity.

Figure 2. Live weight (g) to 39-day-old broilers fed mash in response to varying levels of dietary ME and BP (expressed as digestible lysine level). The 100% ME and BP treatment group is referencing Aviagen's recommendations.



SUMMARY

When considering BP for the feed formulation process, follow recommended dLys and dEAAs/dLys ratios; this is essential for broilers to achieve the performance objectives for growth, feed efficiency, and yield of carcass components. The use of alternative raw materials as a source of protein and/or the adoption of synthetic amino acids such as L-Valine, L-Arginine and L-Isoleucine are required to formulate the recommended BP and reduce reliance on soybean meal. Correct feed form and recommended particle size are also essential to maximize feed intake and, thus, performance. Sieved crumble, coarse crumble, and pellets in the Starter, Grower, and Finisher periods are preferred feed forms because they minimize fine particles. Pellet presentation, unlike mash, permits ME to be reasonably reduced below Aviagen's recommendation without impairing live weight and might represent a cost-saving opportunity.