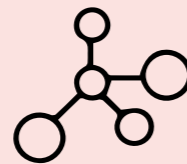


Amino Acids



Optimum Ratio of Branched-Chain Amino acids in Poultry Nutrition



INTRODUCTION

The concept of ideal protein in monogastric nutrition is well established in the scientific community, among nutritionists, feed industries and the producers of monogastrics. Using lysine as a reference amino acid in order to estimate

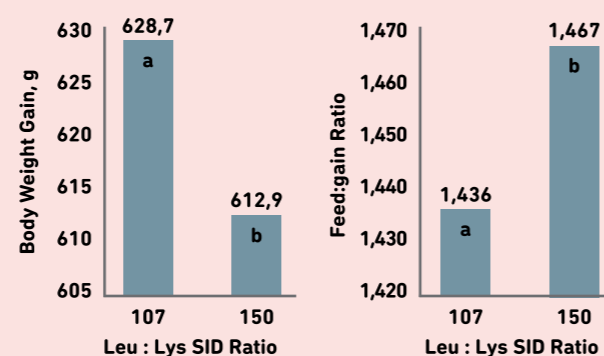
the requirement of the other essential amino acids is a classic and universal routine.

However, as branched-chain amino acids (L-Valine and L-Isoleucine) production technologies are advanced, researchers and nutritionists are encouraged to better understand their interactive metabolism in the body, as well as to establish their nutritional correlation within the ideal protein profiles.

Optimum Ratio among Branched-Chain Amino acids (BCAA)

BCAAs are classified as hydrophobic neutral amino acids: Isoleucine, Leucine and Valine with similar chemical structures. They share common enzymes in the oxidative transamination and decarboxylation process, justifying interactions, mainly in response to excessive leucine ingestion. Research realized by Maia (2013) showed that the leucine:lysine SID ratio of 107 to 150 reduced the weight gain and worsened the feed conversion (Fig. 1) without affecting feed intake. To minimize the negative effect of leucine, the author recommends increasing the valine:lysine SID ratio from 77% to 90%.

Fig. 1. Two leucine:lysine SID ratios and its effect on weight gain and feed conversion of broilers.



Calvert et al (1982) studying the antagonism of branched-chain amino acids, found that increasing the level of leucine in the diet reduced the feed intake, weight gain and feed efficiency of birds. According to Ospina-Rojas (2015) level of leucine and valine interact on poultry performance, suggesting that the dietary addition of valine may partially reduce the negative effect of leucine excess on animal performance.

The information above makes it clear that leucine content directly influences the requirement of valine in broilers (Ospina-Rojas, 2015). This fact indicates the need to establish the optimum ratio among BCAAs as well as their correlation within the ideal protein in poultry nutrition.

Elango et al. (2004) studying parenteral and enteral of feeding in neonatal piglets in order to find the optimum ratio among BCAAs in each route of nutrient supply, observed that the ratio of 1:1.8:1.2 to isoleucine/leucine/valine was suitable for enteral feeding. In view of this observation, the optimum ratio among BCAAs (isoleucine/leucine/valine) in the diets of broilers chickens (Table 1.) was diagnosed by using, as model, the nutritional requirement of Rostagno et al (2017).

Table 1. Optimum ratio among BCAAs based on the nutritional requirement of broiler chickens.¹

Phase	AME (apparent metabolic energy)	Requirement of BCAA SID			Optimum Ratio* (Ile:Leu:Val)
		Ile(%)	Leu(%)	Val(%)	
1-7 d	3000 kcal	0.895	1.43	1.029	1:1.597:1.149
1-21 d	3100 kcal	0.875	1.397	1.006	1:1.597:1.149
22-33 d	3200 kcal	0.84	1.334	0.951	1:1.588:1.132
34-42 d	3250 kcal	0.726	1.152	0.822	1:1.587:1.132
43-46 d	3300 kcal	0.658	1.044	0.745	1:1.587:1.132

- ¹Rostagno et al. (2017) – Brazilain Tables for Poultry and Swine
- *According to Elango et al. (2004) – Journal Nutrition 134: 72 – 78, 2004 (isoleucine/leucine/valine ratio).

As observed, there is a reduction in the recommendation of BCAAs as the broiler age advanced, but little variation is observed in the proportion among these amino acids.

Considering the observation given by Elango et al. (2004), and knowing that BCAA has been shown to exhibit antagonism caused by excessive intakes of any one BCAA, especially leucine, determining the optimum ratio among BCAAs, and, establishing its correlation within the ideal protein profile seems to be crucial steps to achieve the optimal balance of all amino acids necessary to maximize protein synthesis and minimize excess protein.

Thus, to maintain the optimum ratio among BCAA in broilers diets, it is important to first know the BCAA content in feed ingredients (Fig. 2). Ingredients rich in crude protein such as soybean meal, fishmeal, plasma, dried blood cells, blood meal, feather meal, meat & bone meal, and corn gluten, when they are present in poultry diet, generally exceed the requirements of leucine:lysine, reaching levels of 130 to 150%. High content of leucine in the diet increases the catabolism of valine and isoleucine, especially when these latter two amino acids are at marginal levels in the diet (Ospina-Rojas, 2015). According to Maia (2013) there is a co-limitation of valine and isoleucine in diets based on corn, soybean meal and animal by-products.

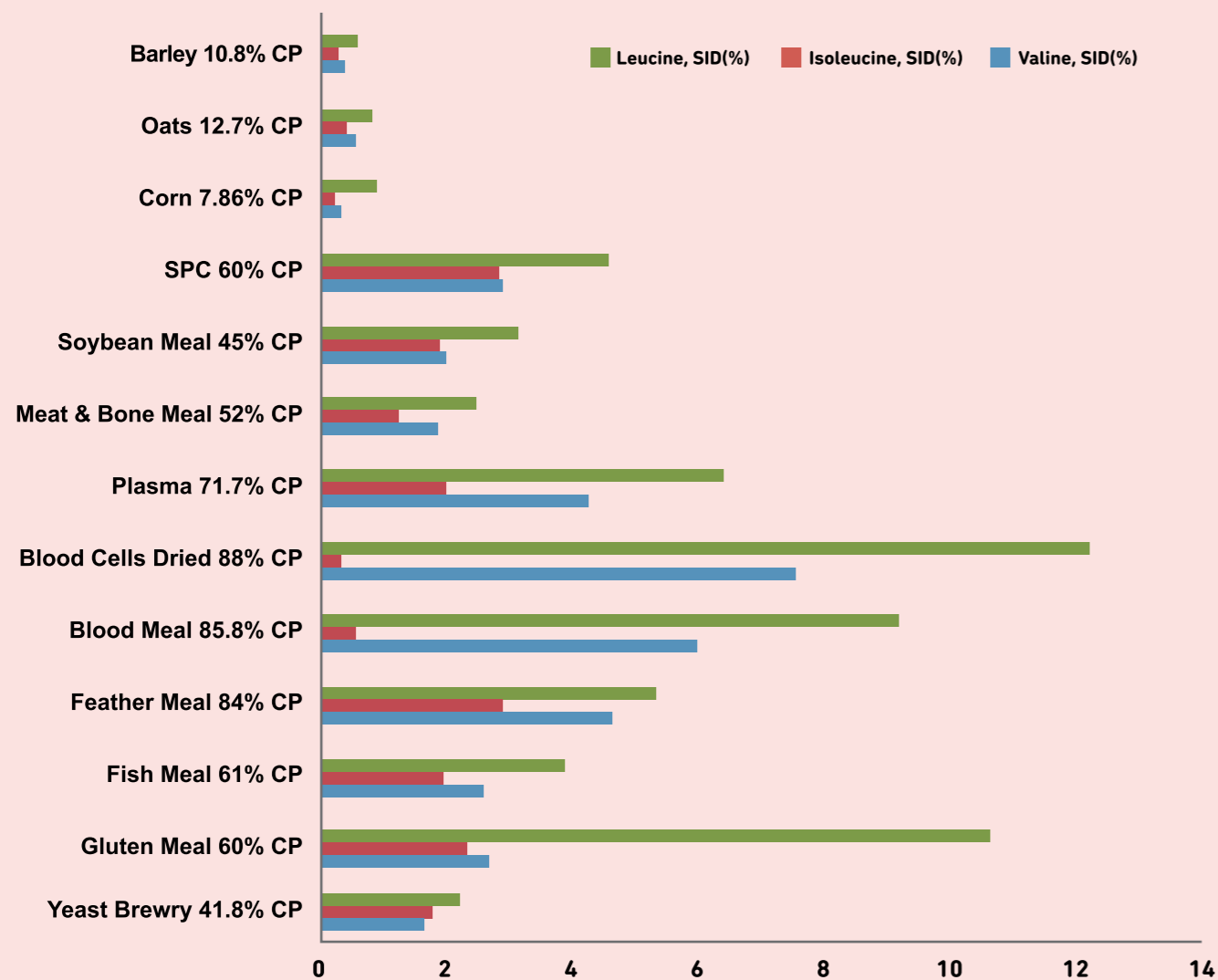


Fig. 2. Content of leucine, isoleucine and valine SID in ingredients for poultry.

Let's evaluate a diet for growing broilers and see how we can apply the optimum ratio among BCAAs (isoleucine/leucine/valine) within the ideal protein profile.

Table 2. Diet without BCAA Feed Grade - Formula

Ingredients	%
Oil	6.12
Corn	49.15
Soybean meal	40.04
Premix	1.20
Salt	0.482
L-Lysine	0.144
L-Methionine	0.293
L- Threonine	0.0547
Limestone	1.057
Dicalcium Phosphate	1.459
Total	100

Table 3. Actual ratio among BCAA of Diet without BCAA Feed Grade

Amino Acid	Req.	Optimum Ratio	Actual Value	Actual Ratio
Ile (68)	0.84%	1	0.89%	1
Leu (108)	1.33%	1.588	1.72%	1.941
Val (77)	0.95%	1.132	0.95%	1.073
Lys (100)	1.235%			

A diet based on corn and soybean meal without application of BCAA feed grade (L-Valine and L-Isoleucine) may present high leucine content (1.720%), depriving the optimum ratio among BCAA (1:1.588:1.132 - isoleucine:leucine:valine) expected to achieve the best animal performance. Although the diet meets the minimum requirement of valine (0.951%) and consequently the valine:lysine SID ratio in the growth phase of broilers, the BCAA ratio (valine/isoleucine SID) is 1.073, is below the optimum ratio expected (1.132). This nutritional diagnosis may indicate a marginal level of valine in the diet, triggering its catabolism.

A formula with BCAA feed grade establishes a better fit in the proportion of BCAAs. For the optimum ratio among BCAAs, increasing the isoleucine:lysine SID ratio and valine:lysine SID ratio in diets with high leucine content appears to be necessary. It also justified within this context, to apply the reduction of crude protein content in the diet.

Table 4. Diet without BCAA Feed Grade - Formula

Ingredients	%
Oil	5.21
Corn	53.86
Soybean meal	35.89
Premix	1.20
Salt	0.481
L-Lysine	0.269
L-Methionine	0.327
L-Valine	0.0685
L-Isoleucine	0.0223
L- Threonine	0.108
Limestone	1.061
Dicalcium Phosphate	1.49
Total	100

Table 5. Actual ratio among BCAA of Diet without BCAA Feed Grade

Amino Acid	Req.	Optimum Ratio	Actual Value	Actual Ratio
Ile (68)	0.84%	1	0.84%	1
Leu (108)	1.33%	1.588	1.63%	1.939
Val (77)	0.95%	1.132	0.951%	1.132
Lys (100)	1.235%			

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