Soybean Meal and DDGS: "You Complete Me"

The Science of Amino Acid Synergy

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"You complete me." Remember that famous living-room scene in the *Jerry Maguire* film? It might seem an unlikely starting point for an article on dairy cattle nutrition, but the sentiment offers an interesting way to look at two familiar feed ingredients: soybean meal (SBM) and corn distillers dried grains with solubles (DDGS). In dairy nutrition, we often evaluate ingredients individually, comparing their crude protein concentrations, energy values, inclusion rates, and cost per ton. Soybean meal has long been recognized as a valuable protein source, while DDGS has become an increasingly important alternative. Yet viewing them primarily as competitors may overlook an important nutritional opportunity. Their contrasting amino acid profiles suggest that, when used together, they may complement one another more effectively than either ingredient alone.

The Amino Acid Imbalance

Lysine and methionine are two essential amino acids of particular importance in dairy cow nutrition. Both contribute to milk protein synthesis, and their availability can influence production responses when dietary supply is limiting. Soybean meal is rich in lysine but contains proportionally less methionine. Conventional corn DDGS has a lower lysine concentration but provides more methionine in relation to lysine. This difference becomes apparent when their amino acid profiles are compared.

Table 1. Total amino acid concentrations of selected feed ingredients

Ingredient	Lysine (%)	Methionine (%)	Lys:Met
Soybean meal	3.04	0.61	4.98:1
Conventional corn DDGS	1.02	0.54	1.89:1
Ground corn	0.23	0.12	1.92:1

Values expressed on an as-fed basis, based on ingredient analyses reported by Yang et al. (2023).

The contrast is revealing. Soybean meal supplies approximately five parts lysine for every part methionine, while conventional DDGS supplies fewer than two. Although DDGS contains less of both amino acids in absolute terms, its lower lysine-to-methionine ratio creates an opportunity to complement the amino acid profile of soybean meal.

When Two Protein Sources Work Together

Consider a simple example combining 2 kg of soybean meal with 4 kg of conventional corn DDGS, both expressed on an as-fed basis. Using the analyzed amino acid concentrations reported by Yang et al. (2023), their combined contributions can be calculated.

Table 2. Illustrative amino acid contributions from SBM and DDGS, as-fed basis.

Amino acid	SBM (2 kg)	DDGS (4 kg)	Total
Lysine	60.8 g	40.8 g	101.6 g
Methionine	12.2 g	21.6 g	33.8 g

Combined lysine-to-methionine ratio: 3.01:1

These calculations use as-fed quantities and should not be interpreted as the amino acid contributions of the dry matter inclusions in Table 3. They illustrate total amino acid composition rather than the supply of digestible amino acids in metabolizable protein.

Combining two ingredients with markedly different amino acid profiles produces a blend containing approximately three parts lysine for every part methionine. This illustrates how complementary ingredients can modify the amino acid balance of a protein mixture, although the resulting ratio does not necessarily represent an improvement in the supply of digestible amino acids to the cow.

However, the apparent precision of this ratio should not be confused with nutritional adequacy. It represents total amino acids contained in the ingredients, not the digestible amino acids available to the cow. Furthermore, a 3:1 ratio in the feed mixture does not establish that the same ratio will be achieved in metabolizable protein.

The Complete Ration Changes the Picture

Dairy cows do not consume protein supplements in isolation. They consume complete rations containing forage, concentrates, and other ingredients that contribute amino acids and influence rumen microbial protein synthesis.

Consider a hypothetical cow consuming 25 kg of dry matter daily.

Table 3. Illustrative dairy ration showing the inclusion of SBM and DDGS (excluding mineral-vitamin supplementation)

Ingredient	Inclusion (kg DM/day)	% of ration DM
Alfalfa hay	5.00	20
Corn silage	6.25	25
SBM	2.00	8
DDGS	4.00	16
Ground corn	7.75	31
Total	25.00	100

The ration contains 45% forage and 55% concentrate on a dry matter basis, with alfalfa hay contributing 20% and corn silage 25% of total dietary dry matter. Soybean meal and DDGS contribute 8% and 16%, respectively, while ground corn accounts for the remaining 31%. Although these ingredients contribute substantially to dietary protein, the forages and ground corn also supply amino acids. Their contributions depend on ingredient composition and inclusion rates, and the nutritional suitability of this hypothetical ration would require evaluation of metabolizable protein, energy, fat, sulfur, fiber, and overall nutrient balance.

"The nutritional value of a protein source depends not only on what it contains, but also on what it contributes to the complete ration."

What Actually Reaches the Cow?

The distinction between total dietary amino acids and those supplied through metabolizable protein is fundamental to ruminant nutrition. Unlike monogastric animals, dairy cows obtain much of their absorbable amino acid supply from microbial protein synthesized in the rumen, with the remainder coming primarily from rumen-undegraded dietary protein (RUP) digested in the small intestine. Consequently, lysine and methionine availability depends not only on their concentrations in feed ingredients but also on ruminal protein degradation, microbial protein synthesis, and intestinal digestibility. Processing adds another consideration, particularly with DDGS, where excessive heating can reduce lysine availability through

Maillard reactions. As a result, two DDGS products with similar crude protein and total amino acid concentrations may differ in their nutritional value (Martins and Hristov, 2026).

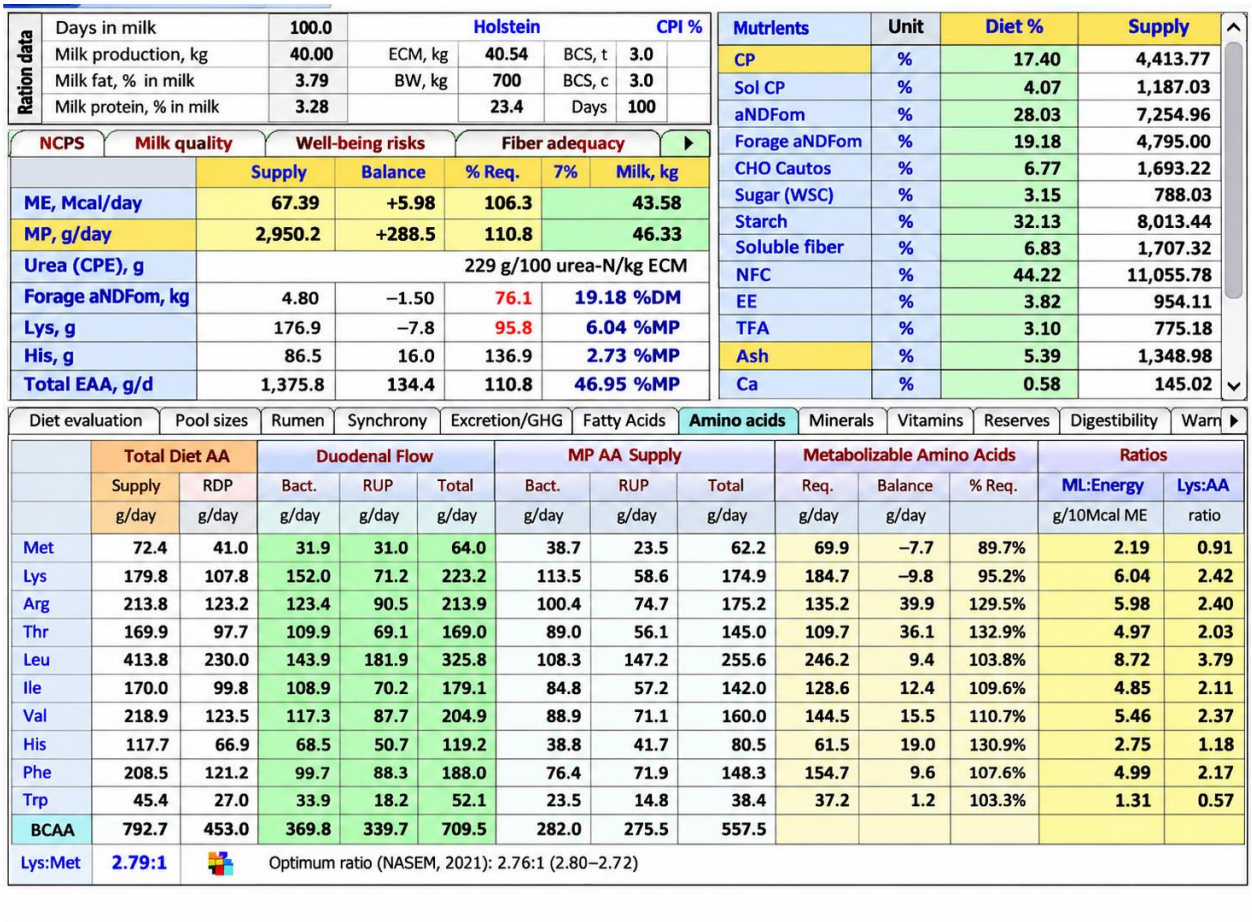
An additional complication is that soybean meal and DDGS differ in their ruminal protein degradability. Conventional soybean meal supplies a greater proportion of rumen-degradable protein, while DDGS contributes more rumen-undegraded protein. Consequently, the lysine and methionine entering the small intestine from these ingredients do not necessarily retain the proportions calculated from their original composition. Moreover, intestinal digestibility differs between amino acids and protein sources, with lysine availability in DDGS particularly susceptible to processing conditions. The 3:1 ratio calculated from total amino acids therefore illustrates ingredient complementarity but cannot predict the amino acid balance of metabolizable protein (Mjoun et al., 2010).

The objective is therefore not simply to achieve a desirable lysine-to-methionine ratio in individual ingredients or the complete ration, but to supply adequate amounts and proportions of digestible essential amino acids through metabolizable protein while meeting the cow's other nutrient requirements. A lysine-to-methionine ratio of approximately 3:1 in metabolizable protein has been used in dairy cow feeding research. Gonzalez Ronquillo et al. (2021) maintained this estimated ratio while evaluating increasing dietary protein concentrations. However, their study did not establish 3:1 as a universally optimal ratio, nor did it directly evaluate the nutritional advantages of combining soybean meal and DDGS.

Modern formulation systems allow nutritionists to evaluate these relationships more accurately than ingredient-level calculations alone. By accounting for microbial protein synthesis, digestible RUP, and the resulting amino acid profile of metabolizable protein, they provide a more reliable basis for determining whether soybean meal and DDGS genuinely complement one another in a complete ration.

Do Soybean Meal and DDGS Really Complete Each Other?

The answer depends on the ration. Soybean meal and conventional corn DDGS have contrasting amino acid profiles that can make them complementary protein sources, although the advantage depends on their inclusion rates and the composition of the complete diet. Soybean meal contributes more lysine, while DDGS provides a greater proportion of methionine relative to its lysine content. Together, they can improve the total amino acid balance of a protein mixture, but whether this translates into better metabolizable protein nutrition depends on rumen function, microbial protein synthesis, intestinal digestibility, and the contributions of other dietary ingredients.



Ration data						
Days in milk	100.0	Holstein			CPI %	
Milk production, kg	40.00	ECM, kg	40.54	BCS, t	3.0	
Milk fat, % in milk	3.79	BW, kg	700	BCS, c	3.0	
Milk protein, % in milk	3.28		23.4	Days	100	

NCPS | Milk quality | Well-being risks | Fiber adequacy

	Supply	Balance	% Req.	7%	Milk, kg
ME, Mcal/day	67.39	+5.98	106.3		43.58
MP, g/day	2,950.2	+288.5	110.8		46.33
Urea (CPE), g			229 g/100 urea-N/kg ECM		
Forage aNDFom, kg	4.80	−1.50	76.1		19.18 %DM
Lys, g	176.9	−7.8	95.8		6.04 %MP
His, g	86.5	16.0	136.9		2.73 %MP
Total EAA, g/d	1,375.8	134.4	110.8		46.95 %MP

Mutrients	Unit	Diet %	Supply
CP	%	17.40	4,413.77
Sol CP	%	4.07	1,187.03
aNDFom	%	28.03	7,254.96
Forage aNDFom	%	19.18	4,795.00
CHO Cautos	%	6.77	1,693.22
Sugar (WSC)	%	3.15	788.03
Starch	%	32.13	8,013.44
Soluble fiber	%	6.83	1,707.32
NFC	%	44.22	11,055.78
EE	%	3.82	954.11
TFA	%	3.10	775.18
Ash	%	5.39	1,348.98
Ca	%	0.58	145.02

Diet evaluation | Pool sizes | Rumen | Synchrony | Excretion/GHG | Fatty Acids | Amino acids | Minerals | Vitamins | Reserves | Digestibility | Warn

	Total Diet AA		Duodenal Flow			MP AA Supply			Metabolizable Amino Acids			Ratios	
	Supply	RDP	Bact.	RUP	Total	Bact.	RUP	Total	Req.	Balance	% Req.	ML:Energy	Lys:AA
	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day	g/day		g/10Mcal ME	ratio
Met	72.4	41.0	31.9	31.0	64.0	38.7	23.5	62.2	69.9	−7.7	89.7%	2.19	0.91
Lys	179.8	107.8	152.0	71.2	223.2	113.5	58.6	174.9	184.7	−9.8	95.2%	6.04	2.42
Arg	213.8	123.2	123.4	90.5	213.9	100.4	74.7	175.2	135.2	39.9	129.5%	5.98	2.40
Thr	169.9	97.7	109.9	69.1	169.0	89.0	56.1	145.0	109.7	36.1	132.9%	4.97	2.03
Leu	413.8	230.0	143.9	181.9	325.8	108.3	147.2	255.6	246.2	9.4	103.8%	8.72	3.79
Ile	170.0	99.8	108.9	70.2	179.1	84.8	57.2	142.0	128.6	12.4	109.6%	4.85	2.11
Val	218.9	123.5	117.3	87.7	204.9	88.9	71.1	160.0	144.5	15.5	110.7%	5.46	2.37
His	117.7	66.9	68.5	50.7	119.2	38.8	41.7	80.5	61.5	19.0	130.9%	2.75	1.18
Phe	208.5	121.2	99.7	88.3	188.0	76.4	71.9	148.3	154.7	9.6	107.6%	4.99	2.17
Trp	45.4	27.0	33.9	18.2	52.1	23.5	14.8	38.4	37.2	1.2	103.3%	1.31	0.57
BCAA	792.7	453.0	369.8	339.7	709.5	282.0	275.5	557.5					
Lys:Met	2.79:1		Optimum ratio (NASEM, 2021): 2.76:1 (2.80–2.72)										

Figure 1. *NDS Professional ration formulated for a Holstein cow producing 40 kg of milk daily, using corn silage, alfalfa hay, ground corn, soybean meal, and DDGS. The formulation excludes supplemental vitamins, minerals, and other additives. Predicted metabolizable lysine and methionine concentrations are 6.04% and 2.19% of metabolizable protein, respectively, yielding a lysine-to-methionine ratio of 2.76:1, close to the model's optimum of approximately 2.7:1.*

Figure 1 presents the practical application of these principles using NDS Professional to evaluate a ration formulated for a Holstein cow producing 40 kg of milk daily. The diet supplies 25 kg of dry matter, including 4 kg of DDGS and 2 kg of soybean meal, together with corn silage, alfalfa hay, and ground corn. Only the principal feed ingredients are included in this example, without supplemental vitamins, minerals, or other additives, allowing the contribution of the major dietary components to be examined independently. According to the NDS predictions, metabolizable lysine represents 6.04% of metabolizable protein and methionine 2.19%, resulting in a lysine-to-methionine ratio of approximately 2.76:1. This approaches the 2.7:1 ratio identified as optimal by NDS, illustrating how soybean meal and DDGS can be incorporated into a complete ration with a favorable predicted metabolizable amino acid balance. However, lysine and methionine supplies meet only 95.8% and 98.7% of

their respective estimated requirements, demonstrating that an appropriate ratio does not necessarily ensure adequate supplies of both amino acids.

There is also an economic dimension. The most appropriate combination is not necessarily the one producing the most attractive amino acid ratio on paper, but the one meeting nutritional requirements at a competitive cost. Ingredient prices, protein degradability, energy supply, and the potential need for supplemental rumen-protected amino acids must all be considered. Successful formulation requires evaluating these factors together rather than assuming that a favorable amino acid ratio automatically translates into improved animal performance or profitability.

The same principle applies to other feed ingredients with complementary nutritional characteristics. Understanding how ingredients interact within the complete ration is often more valuable than evaluating each one independently. That is the nutritional lesson behind this unlikely love story. Soybean meal and DDGS do not necessarily replace one another. Under the right conditions, they complete each other.

Further reading

Gonzalez Ronquillo, M., A. P. Faciola, H. Nursoy, and G. A. Broderick. 2021. "Effect of Increasing Dietary Protein with Constant Lysine:Methionine Ratio on Production and Omasal Flow of Nonammonia Nitrogen in Lactating Dairy Cows." *Journal of Dairy Science* 104 (5): 5319–5331. https://doi.org/10.3168/jds.2020-19541.

Martins, Leoni F., and Alexander N. Hristov. 2026. "Amino Acid Nutrition of Dairy Cows: Invited Review." *Animal Bioscience* 39 (8): Article 260271. https://doi.org/10.5713/ab.260271.

Mjoun, K., K. F. Kalscheur, A. R. Hippen, and D. J. Schingoethe. 2010. "Ruminal Degradability and Intestinal Digestibility of Protein and Amino Acids in Soybean and Corn Distillers Grains Products." Journal of Dairy Science 93 (9): 4144–4154. https://doi.org/10.3168/jds.2009-2883

Schingoethe, D. J., K. F. Kalscheur, A. R. Hippen, and A. D. Garcia. 2009. "Invited Review: The Use of Distillers Products in Dairy Cattle Diets." Journal of Dairy Science 92 (12): 5802–5813. https://doi.org/10.3168/jds.2009-2549.

Yang, Zhaohui, Pedro E. Urriola, Lee J. Johnston, and Gerald C. Shurson. 2023. "A Systems Approach to Evaluate Nitrogen Utilization Efficiency and Environmental Impacts of Swine Growing-Finishing Feeding Programs in U.S. Pork Production Systems." *Journal of Animal Science* 101: skad188. https://doi.org/10.1093/jas/skad188.