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The Rewards of AA Balancing and Ration Formulation

Production | Health | Reproduction

Importance and Considerations of Formulating Diets for AA

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Answers to Questions Asked

Answers Courtesy of:
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Q: The modern models use all the data. Yet with the addition of methionine in a methionine-deficient diet, they don't show an increase in the volume of milk. Only the rates are improved. Why?

A: The current commercial versions of CNCPS 6.5.5, for example, do not predict in the background responses to the addition of individual limiting amino acids (AAs). Until Version 7 is released, maximizing production, components, metabolic health, and reproduction will be achieved by targeting formulation levels for metabolizable methionine of 1.14g/MCal of ME and respecting a LYS to MET ratio of 2.69 to 1.

Q: How do you explain the loss of milk yield in some publications with RP-methionine supplementation? Is it due to a lack of other nutrients or modification of energy partitioning?

A: I remember one publication in particular, Socha et al. 2005, where the level of methionine in the diet, particularly pre-calving but also post-calving, was too high with respect to the other nutrients in the diet, particularly lysine. This actually reduced intake pre-calving, thus milk production was depressed post-calving. Simply by rectifying the AA imbalance pre- and post-calving by adding lysine, ECM was improved by 3.0 kgs over the Methionine treatment. We have come a long way from the early Smartamine® trials. We now understand that to get consistently high performance from diets that include rumen protected (RP)-methionine, all the other nutrients must be in line as well for the targeted level of energy corrected milk (ECM).

Q: How can we use AA balancing in a context where milk production must go down, e.g., lower demand in the market?

A: If the unfortunate "choice" must be to decrease milk yield, this can only be achieved by decreasing the intake of all nutrients, so intake is always the first consideration. Dietary fiber levels need to be increased to a point where the fill factor in the rumen will depress intake. This will decrease milk yield, two-fold, as increasing the fiber level will also decrease energy concentration of the diet. Other nutrient specifications, including methionine (MET) and lysine (LYS) need to be adjusted but only in line with the new, lower targeted production. This is particularly important when milk is paid on components, where maximizing the price per cwt of milk must still be a goal to minimize the revenue loss from capping or decreasing milk production.

Q: Are protected AAs additives or ingredients?

A: Protected AAs are obviously ingredients. They provide one of the potential sources of metabolizable amino acids in diets for formulation, although a very concentrated one.

Unlike feed additives which for the most part exercise their effects independently of the composition of the ration, the interest in using protected AAs is totally dependent on the ingredient profile of the ration. Rumen protected amino acids are not a silver bullet.

Q: Shall we continue talking about metabolizable protein or digestible AA?

A: We will continue talking about metabolizable protein (MP) in the near term, because this is what the current models still emphasize. Going forward, we need to focus on individual amino acids. Amino acids are the nutrients not MP. At best, MP is a proxy for total AAs. Unfortunately, as we know, the AA profile of MP is highly variable and does not predict performance as well as individual AAs.

Q: How important is the AA profile of highly digestible forages if most of them are digested in the rumen by microbial protein?

A: It is important to have a robust amino acid profile for all ingredients including forages. There is a variable portion of the protein in forages that escapes ruminal degradation. It is important to express this as a % of Total AAs not CP, because one of the most variable factors in forage analysis is the % of TAA in crude protein. Secondly, the rate of degradation in the rumen of both the carbohydrate and nitrogen fractions will determine the microbial AA contribution. This is the principal way a forage can influence the total end profile of AAs absorbed by the dairy cow.

Q: Can I use MHA (HMTBa) as a protected methionine?

A: Rhodimet® AT 88 or Alimet® or the Ca salts of either should not be considered protected methionine sources. The role of HMTBa is in the rumen to mitigate milk fat depression.

Q: Can we use individual AA digestibilities for poultry or swine for ruminants once they reach the small intestine?

A: We need to have individual ingredient intestinal digestibilities and individual AA digestibilities within an ingredient particularly for heat treated or processed high-protein ingredients. This is probably the weakest link in all current models used in feed formulation. An interim solution could be to use values determined in swine or poultry. Unfortunately, RUP lysine digestibilities are more affected than the other potentially limiting amino acids by heat, particularly in the presence of sugars (Maillard Reactions). In many cases, rations are probably not delivering the metabolizable lysine contributions calculated by the models.

Q: Should I use protected AA where milk protein and fat is not paid?

A: Yes. All rations should be formulated to meet the AA requirements for production, milk components, health, reproduction, and overall well-being of the dairy animal. Better satisfying the cow's demands for all nutrients ensures the sustainability of the dairy cow and the industry. It is a bonus for the producers who are also paid on a milk component basis.

Q: Can I consider corn byproduct a source of MET?

A: Yes. All protein-containing feed ingredients are sources of MET. However, the secret is through ingredient selection and availability to formulate a ration balanced for LYS and MET at the best cost.

Q: Should we look at RUP, or only RDP and AAs?

A: Ideally, we only need to look at RDP and metabolizable AAs. The rumen needs adequate amounts of peptides, AAs and ammonia that they get from RDP and soluble nitrogen to optimize rumen fermentation, and the cow needs AAs.

Q: Should we analyze AA in forages?

A: It is certainly worth initially checking the book values you are using. As stated previously, the analyses that is ultimately the most important for estimating metabolizable AA supplies are the rates of carbohydrate (CHO) and protein degradation.

Q: What is the interest for beef cattle, goats, and sheep?

A: The interest level is definitely growing. However, progress has been seriously slowed by the lack of available RP-AA supplements that involve AAs other than Lys and Met.

Since 2018, Adisseo has conducted several experiments with highly productive lactating ewes and goats (Lacaune and Saanen/Alpine) in leading public research centers (INRA, AgroParisTech, and University of Barcelona). The results have confirmed specific AA limitations also apply to small ruminants. Indeed, our results suggest that small ruminant diets should be balanced for metabolizable methionine at a rate of 2.5% of MP for animals in mid-lactation and other AA should not be co-limiting.

There is certainly an interest for AAs in beef, but the individual AA requirements still need to be worked out for the different physiological stages of growth, the effect of

breed, the impact of production system (grower, stocker, receiver, finisher), eventual interaction with implants and use of b-agonists.

Q: Does the new NRC consider any individual AA intestinal digestibilities?

A: The intestinal digestibilities will be expressed similarly to the previous NRC, i.e., no individual AA digestibilities.

Q: Are there any results for dairy goats?

A: Since 2018, Adisseo has conducted several experiments with highly productive lactating goats (Saanen/Alpine) in leading public research centers (INRA, AgroParisTech, and University of Barcelona).

Our results have confirmed specific amino acid limitations also apply to small ruminants. Indeed, our results suggest that small ruminant diets should be balanced for metabolizable methionine at a rate of 2.5% of MP for animals in mid-lactation and other AA should be not co-limiting.

Q: In the table from Sok et al. (2017) data, soybean meal (SBM) is in red as a limiting source of Lys. But 16.5% Lys in milk times 80% is 13.2%, which is lower than 13.5% Lys. In this case SBM should not be considered a good source of Lys?

A: Because the value is in red does not imply it as a limiting source of Lys. In fact, as indicated in the table, high-quality soybean meal is a good source of LYS and, depending on its cost and the availability of other ingredients, it is often an important component of a best cost AA balanced diet for LYS and MET.

Q: In the Peter Yoder trial, was the increase in volume associated with a stimulus of lactose synthesis?

A: Lactose yield increased, but lactose % did not change with the addition of isoleucine and leucine, so the animals were able to source additional glucose, the required precursor for lactose synthesis, as well as all other nutrients for additional protein and fat synthesis. The signaling effects of the isoleucine and leucine through the mTOR cascade appear to be the origin of this phenomenon at least for the short duration of the experimentation. Of interest is that whatever the mechanism, the increased yield of milk and milk components was facilitated by increased mammary blood flow.

Q: Do the NRC, CPM and CNCPS models have similar AA values for the RUP feed fractions in their feed databases? And is the difference in requirements due to differences in efficiency of use of Lys and Met?

A: The CPM database was based on a methodology using borate phosphate to precipitate the insoluble protein fraction deemed to represent RUP and determining the AA profile of that fraction. It is a laborious method and the results were sketchy at best. Current CNCPS versions, similar to NRC 2001, drive their AA supply models off simply the original amino acid profile in the ingredient, which is much more robust from a modeling perspective.

Q: Amino acid balancing can enhance milk protein synthesis. Do we know which fraction of casein is promoted? Is it possible we target to enhance α-lactalbumin production, which may facilitate lactose production, thus increase milk volume?

A: In the AA balancing trials where total casein and milk protein have been measured, the increase in milk protein is totally milk casein such that the proportion of casein to protein increases which is a positive factor for cheese manufacture. In theory, providing more potentially limiting amino acids will enhance the protein synthesis machinery at all levels, so why not at the α-lactalbumin level if required? Nevertheless, I would expect the major limitation for lactose synthesis will be glucose as a substrate.

Q: When lysine supplies are increased, why does the ratio of mammary uptake to milk protein usually go down?

A: Lysine is a Group 2 Amino Acid, i.e., its uptake by the mammary gland is in proportion to circulating levels, not demand for milk protein synthesis. Therefore, it is logical that as supply increases and mammary uptake increases the calculated proportion resulting in milk protein synthesis goes down. This is in contrast to a Group 1 AA such as methionine where mammary uptake is regulated to only uptake the quantity needed for milk protein synthesis.

Q: ¿que será mas económico, balancear una racion a MP y ME o adicionar aminoacidos? en México se busca que la ración sea económica pero funcional. aca hay leches con 3.25 a 3.3% de proteina y sin el uso de aminoacidos protegidos y con excelentes conssumos de MS y buenos niveles de producción. cual seria la ventaja de adicionar estos am inoacidos protegidos?

"What will be cheaper: Balance a ration to MP and ME or add amino acids? Mexico seeks to make the ration economical but functional. There are milks with 3.25% to 3.3% protein without the use of protected amino acids and with excellent DM intakes

and good production levels. What would be the advantage of adding these protected amino acids?"

A: I believe in Mexico the milk protein values reported are milk crude protein not true protein, therefore, there is still room to improve milk protein further by ~ +0.15%. This is only the tip of the iceberg, as the real gains to AA balancing are on all around milk performance, metabolic health, and reproduction for a similar ration cost. To do this effectively, give up on the MP formulation constraint and, if possible, use a non-linear optimizer.

Q: Should we feed MET and LYS to heifers?

A: It is probably even more important to balance the rations of first lactation animals for LYS and MET. Depending on their physiological development at calving, they will have in addition to the demand for milk production a need to keep growing. It is essential to support this first lactation animal, as she does not start making money for the dairy until her second lactation.

Q: The lysine response appears strong on milk protein, linear somewhat. Do you know how many of those studies were only supplementing lysine or were supplementing lysine using feed protein?

A: In the dataset for the NRC 2001 that determined the broken stick relationship, addition of Lysine was either by post-ruminal infusion or by feeding a protected lysine product.

Q: Why the production impact of using RP-Met or RP-Lys sometimes is variable from time to other time at the same farm on the field use?

A: It can be variable if all the other nutrient specifications are not also adjusted to support the new targeted level of performance. In other words, if they are the most limiting AA as well as the most limiting nutrients, and there aren't any other obstacles to higher production, then the responses can be great. However, if there are other nutrients or factors more limiting than those AAs than one will see diminished responses to supplemental Lys and Met.

Q: Are you confident in the precision and accuracy of LYS and MET bioavailabilities determined using the UNH procedure?

A: Yes. The procedure has now been fine tuned. The four-day adaptation period ensures the establishment of steady state conditions before sampling starts, which means there is no bias in terms of results with respect to particle size of a product, i.e.,

small particles can move out of the rumen more quickly. The pre-incubation of the products in the TMR for eight hours also prevents any bias in favor of products susceptible to breakdown by simply being in contact with the TMR. When adequate replication is assured, the accuracy of the bioavailability measurement for a product like Smartamine M should result in a determination between 80 +/- 4 pts.

Q: Regarding the plasma dose bioavailability approach, what if blood flow or tissue usage changes depending on blood concentrations of the respective test AA?

A: The advantage of the UNH procedure is the Latin Square design of one-week periods where every cow receives every treatment. The between-cow variation can be large for the reasons stated in the question plus others, but this is managed successfully in this experimental design as can be seen by the small standard errors.

Q: What are your comments /opinion on the seleno-methionine method by Weiss and St-Pierre, 2009, for determining bioavailability?

A: The methodology published by Weiss and St-Pierre is very elegant in concept. I would like to see more published on how to manage animal variation and validation on the precision and accuracy when it is used to compare protected methionine products. It also has to be recognized that it can only be used for evaluation of methionine supplements.

Q: Why are papers getting published that use the milk protein response for assessing bioavailability? I agree that it's a poor method. Other nutrients may limit production when adding Met. The first few grams of absorbed Met give the biggest response, and statistically you are not testing for equivalence at all?

A: You are correct in your assessment of the technique. Unfortunately, the reviewers of the submitted papers on this subject, for the most part, still do not think of rumen protected amino acids as feed ingredients. We do not use milk protein response or any other animal response to determine the level of protein in soybean meal or the NDF content of a byproduct feed, so why would we do so for a protected amino acid? What is critical for a protected amino acid is to determine a best estimation of its metabolizable AA contribution as this is the specification that is needed to compete as an ingredient in AA formulation.

Q: Do you agree with CNCPS recommendations for Met supplementation? If so, why at optimal supplementation is the efficiency (54-57%) of use less than Group 2 AA such as Leu and Lys?

A: I agree with targeting 1.4g MET / Mcal of ME in CNCPS v.6.5.5. In terms of the efficiencies, there are improvements needed before the publication of Version 7.

Q: When formulating with NRC or CNCPS on AA, how many grams of MP short of 100% are you comfortable with? Assume a cow producing 45 kg.

A: For the NRC application integrated in Formulate 2, the MP "requirement" is already adjusted downward as MET and LYS as a % of MP is improved. In CNCPS v 6.5.5, the easiest approach is not to set an MP formulation constraint when optimizing a ration. Just set an ME constraint, a MET constraint as 1.14g MET/MCal of ME and a LYS to MET ratio of 2.69 to 1. More often than not, the MP allowable milk will still fall close to ME allowable milk. When LYS and MET targets are being met, not only is it tolerable to fall 2 to 4 lbs. short in MP allowable, but it is preferable because it is the cost of the marginal MP inclusion which is preventing the full realization of the financial benefits of AA balancing and formulation.

Q: Heifer calves fed corn respond better to corn diets when lactating. Do you think this could be the case with AA, if cost was not of concern?

A: I anticipate that the corn effect mentioned is a consequence of ruminal adaptation, first and foremost, mediated through the establishment of a microbial fauna adapted to corn.

In the case of AAs, the positive benefit would be mediated through achieving a more desirable growth pattern, proper stature, maturity at service and calving, greater first lactation, and lifetime performance.

The answers to the questions are provided in good faith and are the scientific opinions uniquely of Dr. Brian Sloan, Adisseo.