Dietary Protein–How Low Can You Go?

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1. What are the negative consequences in animal metabolism when we overfeed with metabolizable protein? When excess N is fed, it takes energy to convert and excrete the excess N in the urine. In the short term, this can lower milk production. Over a long period of time, this can decrease reproduction and may have other animal health impacts. High milk urea nitrogen levels (>16 mg/dl?) may be an early signal of potential reproductive problems.

2. If I lower CP content in diet, do I also need to lower starch content in fear my post peak cows will gain too much body weight? If MP is adequate in the lower CP diet, then milk production will not really change, and you wouldn't need to change ration starch levels. Check the ration ME and MP balances compared with requirements. An imbalance (ME>MP) indicates that energy could be partitioned to body reserves. In this case, ration energy sources (fat, carbohydrates) could be adjusted to bring the balance closer to the MP balance. In most cases, MP balance should be slightly higher than ME balance.

3. If lowering protein content of the diet, will the amount of urea or protected urea need to be changed as well? This will depend on the other RDP sources used and rumen ammonia balance. As rumen ammonia balance increases, there will be less response to urea as it goes directly to ammonia in the rumen and would just increase the ammonia balance and N excretion via urine. Rumen N balance should be >110% to make sure thar adequate N is available in the rumen. We see rations with rumen ammonia balance >150% of required. If some of that is from urea, then you should be abler to lower urea inclusion rate.

4. Does the feeding of urea have any place in modern dairy rations? It is really a question of rumen ammonia balance. Urea goes directly to ammonia in the rumen. Many of our rations based on silages have less potential to benefit from added urea since the rumen ammonia levels are already in excess of the amount that can be converted to microbial protein by the available rumen fermentable carbohydrates. Urea does increase the CP in the ration but not MP in most of the rations used in the field.

5. Do higher protein diets lead to less need for inert fats or the opposite? The need for added inert fats is more related to ration energy intake compared with ME requirements. If ME is less than required, added fats could be an option. Check the possibility of adding more energy from carbohydrates as an option to increase ME before bringing in inert fat sources.

6. What are your suggestions to improve MP in conditions like in the EU where animal proteins (all sources) are not allowed? I do realize that animal proteins cannot be used in some countries. In my dataset of low CP herds there were a number of these that fed no animal proteins and still made 100+ lbs. (45 kg) of milk. These herds used a blend of RUP sources. All of these use a heat-treated soybean meal or roasted soybeans. They also used rumen protected amino acids. We can formulate rations for high producing cows with or without the use of animal protein sources. Some of our dairy producers specify that animal proteins not be used in their rations.

7. How often do you recommend forage analysis be done to get a good grasp on composition variation so to decide if a protein risk factor is necessary? This will depend some on the variability in the forage storage structure and how rapidly it was filled. If one bunker silo is filled in 1 day and another in 8 days, I would expect less variability in feed nutrient composition in the one filled in 1 day. You should be able to sample this silo less often. We have been doing basic forage nutrient analysis as we fill silos. This gives us an index of variability. In practice, most farms we see are taking forage samples every 2-3 weeks. If large changes are found it would be good to go back and take another sample. Recent work has suggested taking 2 samples of the forage at sampling to get a better value for nutrient content.

8. What are your thoughts on using milk urea nitrogen as an indicator of dietary nitrogen efficiency? Milk urea nitrogen is primarily an indicator of rumen ammonia balance but not an index of the efficiency of capturing intake in milk. The calculation to determine the efficiency of N use includes the grams of N consumed and the grams of N captured and excreted in milk. This is listed as productive N on the CNCPS output. I would like to see this >30% and some herds or groups can approach 40%. Values <30 do indicate an opportunity to adjust rations to improve the efficiency of N use.

9. What level of milk urea would you suggest to see if MP is adequate? I am not as familiar with milk urea as we use milk urea nitrogen values in the U.S. We suggest a range of 8-12 mg/dl for milk urea nitrogen in dairy rations. On a milk urea basis, this is about 17 – 25 mg/dl. Also, see my comments for questions 10 and 13d.

10. Is milk urea content a reliable indicator of the optimal level of metabolizable protein in the diet? If so, what would be your recommended level? Milk urea (and milk urea nitrogen) are indicators of the balance of ammonia in the rumen versus requirements for ammonia. The MP in the cow comes from the amount of microbial protein produced in the rumen plus RUP. Two herds could have similar MP but differ in milk. The best way to check the adequacy of MP is comparing the supply to the MP requirements using a computer model.

11. What is the ideal MUN level? The range we target in our New York Precision Feeding Program is 8 – 12 mg/dl. There are some high producing herds with MUN's of 7. Even though there is some debate, MUN values 6 or lower could indicate limitations in nitrogen availability in the rumen to support microbial activity.

12. How do you use herd MUN to monitor N efficiency if there are different groups/diets within a herd? As you indicate, herd MUN is an indicator of all cows or groups. Herd MUN is like using herd somatic cell data. Neither of these values can be used to look at individual animals or groups within a herd. There are a couple of options. One is to obtain milk samples for each group using in-line milk samplers. This lets you get group MUN values. A second option in some DHI milk testing programs is to measure the MUN for each individual cow. You can calculate group MUN values. Some DHI centers do provide a summary report by lactation or days in milk.

13. Milk urea, how does it differ from milk urea nitrogen? Both are measures of ammonia balance in the rumen. They are determined by different analytical techniques. The milk urea nitrogen value is about 47-49% of the milk urea value. Either one can be used to assess rumen ammonia balance.

14. We have adjusted fresh and high dairy cow rations to 15-15.5% CP, using the CNCPS Model as well as adding rumen-protected amino acids. The animal performance is good and economically profitable in many ways, including milk production and composition, health and ketosis, other metabolic disorders, and reproduction, etc... Do you have any suggestions for more improvements? Great to hear that this is working for you. I would be interested in seeing some of these rations if you are willing to share. I would look at the grams of N excreted in the urine versus the grams of N in the milk. If the urinary N excretion is higher than the grams N in milk, then there would be an opportunity to lower ration N intake. Higher rumen ammonia levels (>130% or so) or MUN's > 10 or so would give an index of an opportunity to decrease ration N intake. Another option is to look at the % of the total MP from microbial protein. If < 50% or so, there could be an opportunity to adjust ration carbohydrate and RDP sources to increase microbial protein production. This would decrease the amount of RUP needed and could lower ration cost.

15. Will lowering protein content in the diet increase the rate of loss of body weight reserves? Basically, will body condition score deplete faster? What can I expect in fresh cows to 50 DIM? Body weight loss is mainly a reflection of energy status. High levels of body condition loss often reflect some limitations in dry matter intake relative to milk production. The first step is to explore options to stimulate and increase dry matter intake. Losses in body condition have a negative impact on reproductive performance. Goal would be to have fresh cows lose < 0.5 body condition score in the first 50-60 days after calving.

16. Body weight loss is mainly a reflection of energy status. High levels of body condition loss often reflect some limitations in dry matter intake relative to milk production. The first step is to explore options to stimulate and increase dry matter intake. Losses in body condition have a negative impact on reproductive performance. Goal would be to have fresh cows lose < 0.5 body condition score in the first 50-60 days after calving? The key to milk production in the fresh cow is dry matter intake and rumen fermentation. The level of milk production is the key driver in determining MP requirement. MP needs can vary from 1,800 grams for a cow producing 50 lbs. of milk to 2,600 grams for a cow at 90 lbs. of milk. Amino acid requirements would also vary with milk production. If we have a 30-40 day fresh cow group, you could formulate the ration for a cow 20 days in milk using dry matter intake for this cow. Some cows produce 100 (45 kg) lbs. milk within the first week after calving. I would look at amino acids in grams comparing required to supply.

17. How much MP for fresh cows? 1800 grams/day? This will depend on cow body weight dry, matter intake, milk production and milk composition. All of these are used to calculate MP requirements. See my answer to question 16.

18. I'm using 12% DM MP in fresh cows (as Weiss suggestion) with good results, what do you think about it? Interesting approach! I quickly looked at a couple of recent studies and the range was 10-12% of DM. Glad to hear it is working. You gave me something to think about.

19. Cows are suffering negative protein balance postpartum during transition period beside negative energy balance. Lowering CP during the transition period, will it decrease cow performance? It is really a question of MP not CP. MP is more predictive of milk production. Trials in the literature report excellent milk production with fresh cow diets at 15.5 – 16.5% CP when MP is adequate. Lower protein transition rations will depress milk if MP is not adequate.

20. Does the implementation of the MP content in the dry cow diet help in the process of reducing the CP supply when the lactation starts? I feel that attention to adequate MP in the close-up dry cow should really help. The current guideline for Holstein cows is 1200 – 1300 grams of MP in the close-up ration.

21. In the Xu 1998 study where additional amino acids were supplied to fresh cows, was an improvement in reproduction and/or body condition seen along with the improvement in milk production that you mentioned? This study did not report body condition or reproduction data.

22. Does feeding low protein diets affect reproductive performance? I am not aware of any controlled research studies on this question. Observations of commercial herds using lower protein rations indicate above average or excellent reproductive performance in many herds.

23. When making reference to MP and AA's as % of MP in your presentation, are those numbers from CNCPS biology or 2001 Dairy NRC? The values I used are from the CNCPS model.

24. Where are you comfortable balancing MP as % of requirement once cows hit peak production? Are you comfortable dropping below 100% of MP requirement in CNCPS? For cows at peak or after, I feel we can balance at 100 – 105% of MP requirements. I am hesitant to go <100% due to daily variation in dry matter intake, feeding management and forage nutrient composition.

25. What are your recommendations for improving nitrogen efficiency in grazing herds? Forage CP is usually high in well managed rotational grazing systems. The protein in a pasture forage is high in RDP but moderate in soluble protein. The rate of degradation to ammonia should be slower than diets with higher soluble protein. The key is to provide adequate rumen fermentable carbohydrate sources to support using the ammonia for microbial growth. Sources used could include steam flaked corn, corn meal or small grains like barley or wheat. A grain mix with both starch and non-starch carbohydrate sources should improve carbohydrate use in the rumen and may increase milk. Adding some non-forage fiber sources to the grain mix (soy hulls, beet pulp, citrus pulp, wheat midds etc.) provide a low starch, fermentable carbohydrate source. By using a mixture of carbohydrate sources, it should improve the use of the ammonia and maintain rumen pH. In a field study we did with herds on pasture, MUN levels of 9 – 13 were observed when the grain mixes were formulated using multiple carbohydrate sources.

26. How accurate is the CNCPS model in predicting MP requirements and supply? How can its accuracy be improved? Same question for the NRC model? It is difficult to compare model predicted MP requirements and supply since there is no "gold" standard value to use. Dr. Mike Van Amburgh has compared the model predicted milk production versus observed milk production. He used 55 research papers with 200 treatments and 15 commercial herds with 50 diets. In this evaluation, the CNCPS model-predicted milk production explained 97% of the variation in observed milk production when ME or MP allowable milk was first limiting. I am not aware that a similar evaluation was done with the NRC model.

27. You can balance metabolizable energy by changing either RDP or RUP, what do you recommend in terms of balancing RDP:RUP relationship (please consider that we have metabolizable protein already balanced)? The goal from both the animal and economics is to optimize rumen fermentation and microbial protein synthesis. This requires RDP and rumen fermentable carbohydrates. In looking at high producing herds in my dataset, RDP is typically 9-10% of total ration dry matter. These values are for CNCPS-based models and are slightly lower than the NRC model.

28. Lower CP diets that still meet MP requirements are RDP deficient, aren't they? I would hope not. If they are low in RDP, then RUP needs to be high. In most cases, it is more economical to drive up RDP to support microbial protein and purchase less RUP. The amount of rumen fermentable carbohydrates will control the amount of RDP that can be used. See the answer to question 27.

29. What equations do you use to convert RDP into metabolizable protein? We do not use an equation to convert RDP to MP. MP is the sum of the amount of microbial protein produced in the rumen plus the amount of RUP in the intestine. RDP contributes amino acids, peptides and ammonia to microbial protein production. There is also contribution of ammonia from NPN sources in the ration and recycled N. Thus, it would be difficult to predict MP using only RDP.

30. Soybean meal vs. canola meal. Which is best (or is there something else) for low protein diets and why? Canola meal is lower in CP and RDP but higher in NDF, RUP and P than soybean meal. It takes about 1.2-1.3 lbs. of canola meal to provide the same amount of CP as 1 lb. of soybean meal. Soybean meal has a higher digestibility of the RUP fraction. Recent studies indicate some benefit in terms of milk and milk protein yield when canola was used to replace soybean meal. We see herds using either source depending mainly on price. I see a lot of rations that contain both canola and soybean meal.

31. With UK diets (low starch diets) how would the feeding of additional amino acids differ? The rumen needs fermentable carbohydrate that can come from sugar, starch or fermentable fiber. Other fractions such as pectin, beta-glucan, and malic acid can also contribute. The amounts and combinations of these vary greatly between herd. I have a dataset of 79 rations in high producing herds or high groups that average 110 lbs. (50 kg) of energy-corrected milk (range = 98 to 128 lbs. milk). Ration starch averaged 27% with a range of 20 to 33%. The lower starch herds tend to have higher levels of fermentable fiber (both forage and non-forage sources). The use of additional amino acids will depend on microbial protein synthesis in the rumen from fermentable carbohydrates. If fermentable carbohydrates are low, then more RUP or rumen-protected amino acids will be needed. High quality forages can provide lots of fermentable carbohydrates.

32. What kind of amino acids are needed in hot climates? The types of amino acids needed in hot climates don't really change. However, there may be a benefit from using rumen-protected amino acids. See my answer for question 37.

33. Whenever we reduce dietary CP (lower than 16.5% CP), must we balance for Lysine and Methionine? This will depend on MP and the grams of amino acids provided in the MP versus the grams of amino acids required. I always look at this in the rations I see or work with. As milk production increases, the need to balance for amino acids goes up. There becomes a point where the grams of amino acids provided by microbial protein and RUP do not meet the amino acid requirements and rumen-protected amino acids will be needed.

34. Do you think that the Lys / Met ratio is a good parameter to assess the effectiveness of MP or should we be satisfied with the intake in grams? I feel that the actual grams is a better way to evaluate amino acids. This is what the cow requires but it will take time for the industry to adjust. The amino acid requirements are driven by milk production and milk composition. Just like any other nutrient, cows need pounds, grams and milligrams, not % and ppm. The lys/met ratio could be fine but if the cows are short of MP then milk produced will decrease. The next refinement may be determining amino acids based on ME intake like the approach used in swine and poultry. Dr. Mike Van Amburgh has suggested that the methionine requirement can be calculated as 1.19 times the Mcal of ME in the ration. Lysine would be about 2.7 – 2.8 times the methionine requirement in the CNCPS 6.55 program. Additional work is needed on this concept and the actual numbers will vary if using other models.

35. Were bypass AA implemented in the Delaware County field trials? Amino acids were balanced for in the 3 highest producing herds but not in the other 5 herds. After some on-farm management adjustments are made, there would be an opportunity to balance for amino acids in these 5 herds. Variations in forage quality and feeding management practices need attention on these herds. These herds were selected to represent the feeding practices and milk production levels similar to other herds in the region.

36. Are you familiar with Compact TMR mixing? Have you seen the benefits on farm with lower protein diets mixed this way? I have seen information on the compact TMR system but don't have any direct experience or observations. This system should decrease sorting by the cow and provide a more consistent ration. This should improve the ability to use lower protein rations, but I have not seen any data on this aspect.

37. How low can we go with dietary protein when the forage quality is a big issue and heat stress is present for 5-7 months? Heat stress results in decreases in both dry matter intake and milk production. About 50% of the decrease in milk is due to the change in dry matter intake. The rest is due to shifts in nutrient availability and use. There is a shift in blood flow from the animal's core to peripheral tissues. This can lower the nutrients available for milk production. Animal maintenance requirements also increase during heat stress which also reduces the nutrients available for synthesizing milk. The best way to counter the effects of heat stress is to implement fans and other cooling techniques. These usually have a rapid payback versus the investment. There are some adjustments that can be made in the nutrition program. Added fats may help in providing energy to the cow. Using highly digestible feeds and forages is a benefit. Feeding high levels of RDP (rumen degradable protein) increase energy expenditure in the cow to convert this to urea-N. Recent work indicates that lowering RDP and increasing RUP fraction may help in getting more nutrients absorbed to support milk production. This work also indicates that there can be a benefit in using rumen-protected amino acids to increase the supply of amino acids for milk protein synthesis. Don't forget to provide adequate water as heat stressed cows may drink 30-50% more water.