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NDS Dynamics

Welcome to the NDS Dynamics newsletter!

After the summer break (for many countries), the NDS Dynamics newsletter is back with some more news! First of all, thanks to the suggestion of one of our readers, we adopted a magazine layout to make the reading easier on smartphone and tablets. Additionally, since it has become a routine of the past few issues to publish a technical note on the latest NDS Professional updates, the team at RUM&N decided to officially introduce the column "NDS Updates". In this issue, the column will cover the latest update on the High-Risk RUFAL calculator.

The RUM&N team, with the support of the NDS-North America group is also quite active on the youtube channel. The latest video uploaded is: "Feeding for Amino Acids: Optimizing the Fundamentals". In the presentation, Andrew Lapierre, a PhD candidate in nutrition at the department of Animal Sciences at Cornell University, among other things shows how NDS can be used towards a more efficient use of dietary amino acids.

Take a look at the video by scanning the QR code below or by clicking here

NDS UPDATES

Rumen Unsaturated Fatty Acids Load (RUFAL): determination of high-risk RUFAL based on fat source and accessibility index

By G. Esposito[1], E. Melli[1] and T. Jenkins[2]
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Introduction

Diets fed to lactating cows usually contain low levels of fatty acids (FA; Palmquist and Jenkins, 1980). In fact, fatty acids concentration in forage and grains fed to lactating cows is usually between 2 to 4% DM (Jenkins, 2013). Due to their high intake, the basal diet itself can already account for up to 70% of total unsaturated fatty acids (UFA) consumed, satisfying also the requirements for essential fatty acids (EFA), such as the linoleic and linolenic acids, which are needed for proper tissue function but not synthesized by it. High production demands, however, may stress EFA balance. Therefore, in the recent years it has been common practice to introduce fatty acid supplements in dairy rations not only to increase energy density, but also to ensure adequate levels of EFA. This has often led to overlooking lipid contributions from the basal diet with much of the focus directed only at the fatty acid contributions from the fat supplements.

As a result of ignoring basal lipid contributions, variability in animal responses often do not line up with added fat levels, with the risk of disrupted ruminal fermentation and milk fat depression caused by excessive amount of unsaturated fatty acid supply (Jenkins 2013). Therefore, it has become necessary to propose the concept of Rumen Unsaturated Fatty Acid Load (RUFAL) defined, by Jenkins et al. (2009) and Lock (2010), as the supply of dietary unsaturated fatty acids in relation with their potential to disturb ruminal fermentation and trigger milk fat depression in lactating dairy cows.

Among the UFA found in dairy rations, 18:3 is the predominant FA in grass and legume forage species, followed by 18:2 (Boufaïed et al., 2003), whereas 18:2 followed by the FA cis 18:1 are predominant in both corn grain and corn silage (Morand-Fehr and Tran, 2001). Based on these observations, RUFAL is calculated as the sum of the three primary unsaturated fatty acids consumed by dairy cattle, namely oleic (C18:1), linoleic (C18:2), and linolenic (C18:3) acids, and reference values for dairy cows are suggested. Jenkins (2013) suggests that to minimize the risk of production problems, RUFAL provided by the diet should no be over 3.5% of DM.

Therefore, RUFAL, by definition, accounts for intakes of unsaturated fatty acids from all feed ingredients, including bypass fatty acids (Jenkins 2013). However, different fat sources have variable effects on fermentation. The variable effect can be attributed to a few basic differences in the lipid structure of different fat sources. For example, unsaturated fatty acids inhibit fermentation more than saturated fatty acids (Chalupa et al., 1984, Palmquist and Jenkins, 1980). Furthermore, some fatty acid derivatives, such as Ca salts of long chain fatty acids and triglycerides have a reduced effect on inhibiting fermentation compared to free fatty acids.

High-risk RUFAL and accessibility index in NDS

Given that not all fat sources would interfere with rumen function or production at the same level, the concept of High-Risk RUFAL was recently introduced and discussed with Dr. Tom Jenkins.

RUFAL can be in fact classified as high-risk RUFAL when they are easily released in the rumen, therefore subject to biohydrogenation from bacteria. So, the challenge is how to partition out high-risk RUFAL from total RUFAL.

A first step in the quantification of high-risk RUFAL supply is to account for the unsaturated fatty acids from sources other than inert/protected fats (i.e.: free oils, ground oilseeds, bakery wastes, corn coproducts, etc.), that could interfere with the rumen functions and butterfat yield.

However, to quantify the risk, it is important not only to account for the fat source, but also to consider that its negative effects are a function of how rapidly these fatty acids are available to microbes in the rumen, in other words, how accessible they are.

To properly take this aspect into account, it may be useful to consider the physical form of potentially “risky” fat sources, for example distinguishing between hard outer seed coat and softer outer seed coat or between fine and coarse ground feeds.

The rationale of this assumption, supported by many field observations, is that whole seeds (e.g. cottonseed), or lightly processed feedstuffs (such as rolled soybean) will have less accessible fatty acids and, therefore, a reduced deleterious effect. Further processing (reducing particle size) of higher fat feedstuffs will result in increased negative effects on rumen fermentation.

This concept led to the definition of the **Accessibility Index** to estimate the supply of High-risk RUFAL.

Based on the feed classification and physical form allowed by NDS, an Accessibility Index ranging from 0 to 1, has been assigned to all the feeds included in the diet according to the following description:

NDS Dynamics

Accessibility Index = 1: applied to RUFAL from base feed ingredients like chopped or processed forages and grains

Accessibility Index = intermediate values: applied to RUFAL from high-fat feed ingredients containing rumen active fats like whole and ground oil seeds, distillers grains and corn co-products, free oils.

In our discussion with Tom Jenkins, three levels of accessibility were defined based on the physical forms of the feed:

- low accessibility (range 0 to 0.3)
- medium accessibility (range 0.4 to 0.7)
- high accessibility (range 0.8 to 1.0)

Accessibility Index = 0: applied to RUFAL from fat inert in the rumen because fat is in the form of calcium salts.

The funcion in NDS

With this update, when formulating a diet in NDS, one of the parameters reported in the NCPS window is "Total RUFAL g/day (% DM)" with the corresponding supply of "High-risk RUFAL g/day (% DM)", which is now calculated according to the accessibility index described above (figure below).

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

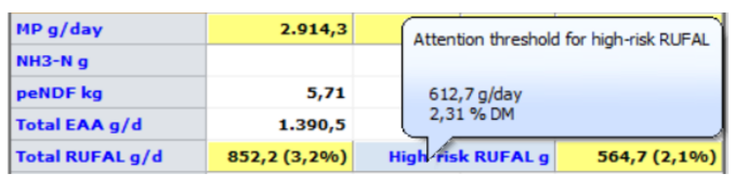
	Supply	Balance	% Req.	Milk kg
ME Mcal/day	69,79	0,06	100,1	44,90
MP g/day	2.914,3	12,2	100,4	45,13
NH3-N g		102,8	146,1	
peNDF kg	5,71	-0,40	93,5	21,51 %DM
Total EAA g/d	1.390,5	29,1	102,1	47,71 %MP
Total RUFAL g/d	852,2 (3,2%)	High-risk RUFAL g		564,7 (2,1%)
Met g/Mcal ME	0,89	-0,28		1,17 opt.
Lys g/Mcal ME	2,80	-0,36		3,16 opt.
[Na + K]-[Cl + S]	mEq/100g	+21,4		

Also, in order to provide a safety threshold for diet formulation, the model estimates the maximum acceptable level of High-risk RUFAL based on Tom Jenkins's proposal:

Max High-risk RUFAL (% DM) = 4 x ration NDF level (%DM) / High-risk RUFAL (% TFA)

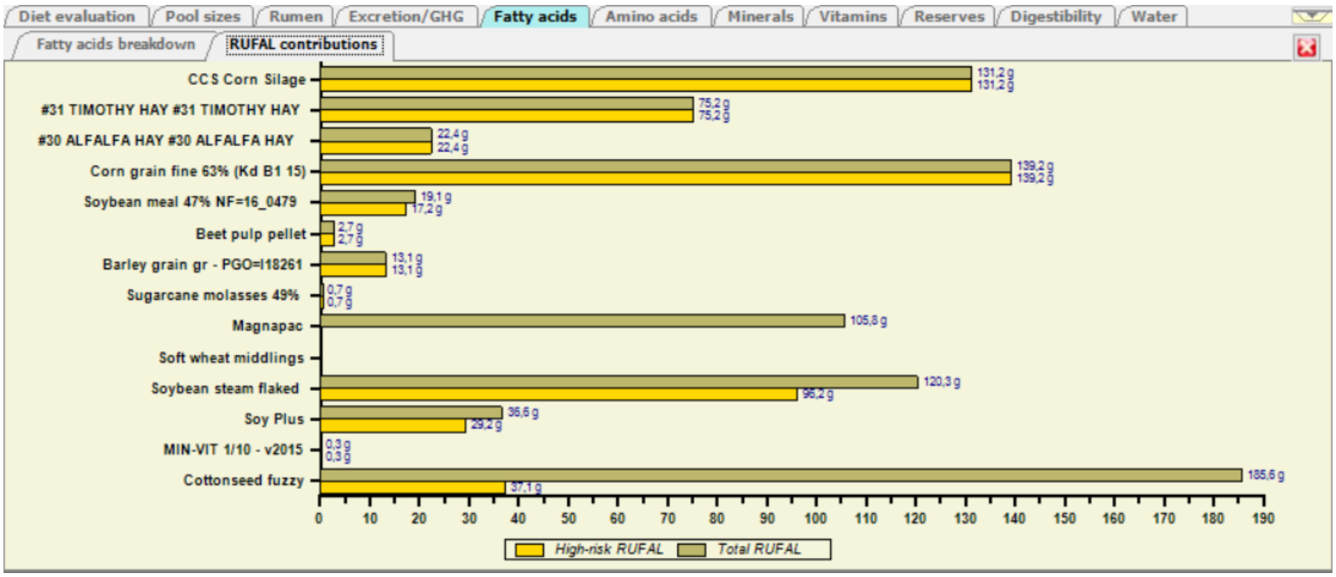
According to this approach, the maximum amount of High-risk RUFAL that can be placed into the diet is calculated based on the NDF Level of the total diet. This is because the amount of rumen active fat that can be fed increases as the NDF level of the diet increases (T. Jenkins personal communication) Thus NDF levels in diets for lactating cows is the limiting factor for the amount of High-risk RUFAL that can be supplied.

By moving the mouse over the label "High-risk RUFAL", a pop-up will appear with the suggested maximum level.



An additional feature has been included through the main Fatty acids tab in the Recipe screen. In the charts section, it is available a new chart within RUFAL contribution sub-tab that allows High-risk RUFAL to be compared against total RUFAL for feeds included in the recipe.

NDS Dynamics



Conclusion and implications

The RUFAL concept, as it was initially developed to better indicate fermentation disruption in the reticulo-rumen, was only able to give the nutritionist a general indication on the RUFAL supply. The introduction of the high-risk RUFAL concept, based on the fat source, was already a step forward.

With the addition of the accessibility index, which takes into account not only the fat source but also feed processing and particle size, the team at RUM&N aims to equip the NDS platform with an even more accurate tool able to orient the user regarding the risk of fermentation disruption in the reticulo-rumen and of milk fat depression. The system proposed is not without its weaknesses. For instance, it may not be entirely correct to apply an Accessibility Index = 0 to all rumen inert fats due to a possible partial dissociation of Ca salts.

The Accessibility Index system included in NDS Professional is an evolving tool which may be subject to improvements as soon as new experiences and new data are available.

Mass Balance: What is it and why is not always 100%?

By K. Cotanch

The purpose of the mass balance value is to provide a quick check of the lab analyses to determine if there is any possible error. The logic is that the sum of the primary feed components should equal 100% on a DM basis. The CNCPS mass balance equation is:

CP + aNDFom + Sugar(WSC) + Starch + EE + Sol Fiber + Org Acids + Ash = 100%

This equation is the “Gold Standard” for CNCPS based software as presented at CNC 2018, and NDS adheres to this equation to calculate the mass balance.

However, we often receive questions regarding the NDS calculated Mass Balance values of feeds when forage lab analyses are loaded into the platform. Some forages result in mass balance values greater than 100%. How does this happen and what to do about it?

There are occasions when the forage lab results, when entered into NDS, result in mass balances greater than 100%. This can occur in forages with high levels of Organic acids (OA) or possibly high WSC values. When the mass balance value in NDS is between 100 and 103%, NDS will automatically adjust the Sol Fiber to correct the mass balance to 100%, once the feed is saved (thus the

NDS Dynamics

Soluble Fiber (Sol Fiber) could possibly also have negative values). Recall that Sol Fiber is not directly analyzed but simply calculated as the remaining carbohydrate fraction of non-forage carbohydrates (NFC) after analysis of OA, sugar, and starch.

NFC = OA + Sugar (WSC) + starch + Sol Fiber;

NFC can also be calculated as: Total CHO – aNDFom = NFC, as noted in the NDS Constants Calculation tab of a feed. Thus, NFC becomes a fixed value and after entering the OA, sugar and starch values, Sol Fiber is used to adjust mass balance to 100%.

If the mass balance is greater than 103%, NDS will **NOT** make any internal adjustments with the understanding that there is something odd about the analysis of this feed. Therefore the suggestion is for the user to follow up to determine what nutrient values might be in error. The soluble fiber value will remain negative and highlighted in red, but the platform will still function, assuming in the background a zero soluble fiber.

These adjustments will affect nutrient utilization and ultimately ME and MP predicted milk. The greatest impact will be on predicted microbial protein yields as soluble fiber generally results in greater microbial yields than OA or WSC.

The use of WSC (water soluble CHO, more complex sugars, and possibly soluble fiber components) rather than ESC (ethanol soluble CHO, simple sugars) may also be a contributing factor in mass balance errors.

Lastly, some forage labs are providing mass balance summations on their reports using modifications of the CNCPS equation, but these adjustments do not carry through in the .xml file loaded into NDS. In many cases these adjustments make biological sense but stray from the CNCPS equation. For example, discounting some of the OA that can volatilize during lab drying, but then get added back as DM into the mass balance may seem sensible. However, this can result in confusion as NDS does not make the same adjustment. Other labs are making their own adjustments as well. When DM basis nutrient values are loaded into NDS mass balance discrepancies can appear extreme. In attempts to resolve these discrepancies, the Rumen/NDS group is in discussion with the CNCPS leading team at Cornell University on best solutions.

Other relevant equations:

Total CHO = 100 – (CP + Fat + Ash)

100 = CP + aNDFom + Fat + Ash + NFC

Send us your comments on this topic! Emiliano Raffrenato is at emiliano.raffrenato@rumen.it; Giulia Esposito is at giulia.esposito@rumen.it; Dave Weber is at rumendvm@gmail.com

Note that the features and utilities developed by the NDS team are not components of the underlying CNCPS model. None of the original CNCPS structures or equations have been changed in the NDS platform. NDS does provide sub-models and utilities to provide enhanced predictions based on the original CNCPS model. *Questions about the use of these features should be directed to the NDS support team, and not to the CNCPS group at Cornell.*

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