IMPLEMENTING CNCPS 6.5

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INTRODUCTION

The current version of the Cornell Net Carbohydrate and Protein System (CNCPS6.5; VanAmburgh et al., 2015) introduces several new concepts. These updates pertain to moving from CNCPSv6.1 (Tylutki et al., 2008) to CNCPSv6.5. Taking full advantage of these new concepts requires adopting new feed analytical methods. As previously presented at this conference, these analytical methods include: aNDFom, multi-time point DNDF for carbohydrate C pool size and B3 pool size and rate calculations, amino acids, and nitrogen intestinal digestibility.

CNCPSv6.5 CHANGES

The commercial laboratories (namely CVAS, DairyOne, DairyLand, and Rock River) have been heavily focused on implementing the new assays. In the case of aNDFom, this required the laboratories to develop updated calibration equations. This is due to adding an additional step in the aNDF assay: ashing the residue post-aNDF. In conversations with the lab managers, the resulting calibration statistics are improved as would be expected. This is because an NIR relies upon carbon containing bonds for reflectance and soil contamination contains no carbon. In the case of wet chemistry, this extra step does increase turn-around time and cost as additional equipment and labor is required. However, in feeds such as hay crops and root crops (beets for example), soil contamination can easily account for 3-20 points of ‘NDF’.

The second area revolves around the new methods to determine carbohydrate pools B3 and C (CHOB3, CHOC) and the degradation rate for CHOB3 (kdCHOB3). For forages, the new method requires a 30, 120, and 240 hr DNDF while for non-forages, 12, 72, 120 hr DNDFs are required (Raffrenato et al. 2009). These results are then used with a non-linear, dynamic model, to calculate an integrated kd for CHOB3. This is opening many new areas for research as it appears that DMI is highly correlated with total CHOC in the rumen. Notice CHOC is being used here as the uNDF240 (and 120 for non-forages) is the CHOC pool inCNCPSv6.5. There is much confusion being introduced by groups discussing uNDF30 or uNDF240. The research to date has focused on the 240 hr relationship with rumen fill and dynamics. The laboratories have developed NIR predictions for the forage time points. Again, with very positive feedback from the labs regarding prediction statistics. However; for non-forages, the DNFD time points must be done via wet chemistry as there are insufficient sample numbers at this time to develop calibrations.

The third area focuses on amino acids (Van Amburgh, et al. 2015). CNCPS6.5 revamped the entire amino acid structure. These changes relate to several areas. The first is the composition of all feeds. Historically, amino acids were expressed as a proportion of the insoluble residue. In this method, a standard soluble protein assay was conducted and amino acids determined on the residue. This method had never been adopted by commercial labs. While it was available on special request, very few samples and products were analyzed resulting in a mixed feed library. Furthermore, the second issue related to analytical methods, specifically sulfur containing amino acids. The net result was that nearly every feeds MET values were under-reported nearly 50%. The third area was related to the efficiency of use for amino acids. Historically, CNCPS had different efficiency values for maintenance and lactation. LaPierre et al. (2007), at this conference, presented research results for combined values. CNCPS6.5 adopted these combined values along with a revamped feed library.

The fourth area relates to measuring nitrogen intestinal digestibility. Ross evaluated several different methods. Historically, CNCPS has relied upon the detergent system to estimate protein pools and digestibility. While adequate for forages, it has been shown to be poorly correlated with protein pools and digestibility's in other protein products. As an example, what do NDICP and ADICP in blood meal represent? The objective was to develop an assay that could measure intestinal digestibility accurately and able to be implemented by the commercial labs for all feeds. Other methods (e.g. Modified Minnesota Three-Step, Ceasectomized Rooster, Mobile Bag) require specially prepared animals. Additionally, Ross found that the enzymes utilized by some methods were inconsistent and, in some cases, did not match cattle intestinal enzyme profiles. The new Ross method includes a 16-hr *in vitro* to estimate RUP, an acid hydrolysis estimating abomasal action, and then enzyme exposure estimating small intestinal action. The value reported is estimated intestinal indigestible nitrogen (IUN). The assay was evaluated with a lactation study (Gutierrez-Botero et al., 2014). In this study, two blood meal sources were used representing two different intestinal digestibility. Diets were iso-nitrogoneous and formulated to be MP limiting. According to the assay, there was a 20 g difference in nitrogen digestibility. Trial results showed a 2 kg difference in milk production. Evaluations with CNCPS6.5 compared ADICP (predicted no difference) and the IUN. The IUN results predicted a 2.5 kg difference in milk production. This shows the sensitivity of this new assay.

IMPLEMENTATION

As a licensee, AMTS LLC implemented CNCPS6.5 biology with extreme care. The updates required repopulating all feed libraries and core biology changes. This required several interface changes and preparing multiple training materials prior to release. Throughout this time, AMTS evaluated diets from dairy farms and ingredients. One ingredient, AminoMax, was selected for further analysis incorporating all CNCPS6.5 updates. AFGRITec LLC, Watertown NY, manufactures AminoMax, a patented process to treat canola and soybean meal. The quality control program includes sampling all in- and out-bound loads. Given the manufacturing process, the company expressed a large

interest in evaluating the product with the assays. Samples were submitted from various production, and experimental, runs to a commercial laboratory and Cornell University.

Table 1 contains the NDF analytical values utilized in this evaluation. Nutritionists for years have reported cows respond differently to canola meal then standard analytical results and models would suggest. Given that AminoMax is a treated soy/canola blend, these results clearly show there is significantly more available NDF then previously reported. As Table 2 shows, the lignin x 2.4 relationship for determining CHO C pool size greatly over-estimates the undigestible pool compared with 120 hr DNDF. In this case, the relationship is 1.36 x lignin indicating significant lower lignin cross-linking within the NDF matrix. Shifting the potentially digestible NDF pool from 29.7 to 60.2% NDF has significant impacts on ME and MP flows. Assuming a 6% passage rate, this pool size shift, and new kd calculations, result in 256% greater potential NDF degraded. Utilizing AMTS.Cattle.Professional, when fed at 2 kg, this equates to 0.5 kg higher ME and MP allowable milk production, 13 g MP, 1 g LYS, 1 g MET, and 175 g lower CHO C when using the new NDF digestibility methods.

Table 1. AminoMax fiber components and digestibility.

	Analytical Values	Units
aNDFom	28.0	% OM
Lignin	8.2	% DM
12 hr DNDF	34.1	% NDF
72 hr DNDF	57.7	% NDF
120 hr DNDF	60.2	% NDF

Table 2. AminoMax Carbohydrate (CHO) C and B3 pool size and B3 degradation rate.

	CNCPS6.1 Based	CNCPS6.5 Based	Units
CHO C	70.3	39.8	% NDF
CHO B3	29.7	60.2	% NDF
CHO B3 kd	4.5	7.1	%/hr

Amino acid composition is shown in Table 3. As has been observed with all feeds, the change in methodology (%ISR vs %CP) changed values 1-20%. Some ingredients saw small changes, while others such as canola resulted in significant changes. Lysine in canola meal, for example, changed from 6.7% ISR to 5.7% CP. The CNCPS6.1 MET value (2.47% ISR) for AminoMax was a measured value. This highlights one of the issues Cornell identified with CNCPS6.1 amino acids. Namely, the improper hydrolysis and extraction prior to HPLC analysis accounting for approximately 50% of sulfur containing amino acids. Raw canola MET values changed from 1.4% ISR to 2.1% CP in the CNCPS6.1 to CNCPS6.5 transition. This highlights the issue of CNCPS6.1 library being confounded by improvements in amino acid analytical methods resulting in a ‘mixed’ library. Ingredients that were analyzed after the analytical error was determined, and corrected, all showed higher MET values. The analytical error was not well known or discussed, therefore, much confusion was observed when discussing MET with nutritionists.

Table 3. Amino acid composition of three ingredients comparing CNCPSv6.1 (%ISR) and CNCPS v6.5 (%CP).

	6.1	6.5	6.1	6.5	6.1	6.5
	Canola, expellers		Soybean Meal		AminoMax	
Methionine	1.4	2.1	1.3	1.3	2.5	2.0
Lysine	6.7	5.7	6.5	6.1	6.4	6.0
Arginine	6.8	6.1	7.7	7.3	6.8	6.7
Threonine	4.9	4.4	4.8	3.9	4.7	4.7
Leucine	8.0	7.0	8.7	7.6	8.2	8.2
Isoleucine	4.9	4.2	4.0	4.5	5.0	4.5
Valine	6.4	5.3	4.4	4.7	6.2	5.8
Histidine	4.0	2.6	2.7	2.6	3.8	2.9
Phenylalanine	4.7	4.0	5.2	5.1	4.9	4.8
Tryptophan	1.2	1.5	1.4	1.3	1.2	1.2

The Ross IUN results introduce a very interesting issue. Non-forage protein ingredients are critical for ruminant nutrition. It is well known that any process that involves heat decreases protein and amino acid intestinal digestibility. It is also well known that ADICP is inappropriate for estimating protein intestinal digestibility. As Cornell research has demonstrated, this assay is very sensitive allowing predicted performance to match observed milk production closely. This assay can be used as a component of manufacturing process control in the production of by-pass products. It is generally accepted that the IUN be implemented; however, given that this deals directly with commercial products, the first company to publish IUN results may be put at a competitive disadvantage as the values will be lower then any ADIN result.

Canola and soybean meal samples were submitted to Cornell for IUN analysis (Table 4). Five samples of unprocessed canola averaged 25.5% total N IUN (SD 2.6%). Processed canola (n=10) resulted in an average 19.9% total N IUN (SD 2.7%). At first glance, it would appear concerning that IUN of processed was lower then raw canola. However, this would suggest that the increase in RUP via processing results in a very highly digestible RUP fraction. Compared with the detergent methodology (ADICP), IUN is higher for all samples (unprocessed and processed, canola and soybean meal). These results should come as no surprise as the detergent system was never designed to evaluate protein digestibility.

Nutritionists have debated the value of different feeds and analysis for many years. This has resulted in over-feeding nutrients, thus potentially increasing cost and excretion. Canola is an excellent example of this conundrum. It is also important to understand that just because the Protein C fraction of canola increases 3x does not mean the canola is any worse. The new assay is akin to changing currency in that canola intestinal digestibility has always been lower but the detergent system was unable to describe this. Implementing the IUN assay will allow nutritionists to make more informed decisions and formulate more efficient diets. These statements are supported by data from Miner

Institute research where AminoMax was fed in a direct replacement (pound for pound dry matter) for another commercial by-pass protein. There was no statistical difference in any measured parameter with the exception of MUN with AminoMax fed cows lower (9.6 vs 11.4 mg/dL for AminoMax and competing product; respectively) (Tucker et al., 2015).

Table 4. Intestinally unavailable nitrogen (IUN %N) of unprocessed and processed canola and soybean meal.

	Canola Meal			Soybean Meal		
	Avg.	SD	n	Avg.	SD	n
Unprocessed						
ADICP (%CP)[a]	8.4	n/a	n/a	1.8	n/a	n/a
IUN (%N)	25.5	2.6	5	10.6	n/a	1
Processed						
ADICP (%CP)	9.4	0.7	6	1.2	0.3	5
IUN (%N)	19.9	2.7	10	10.8	1.6	3

[a]Values from CNCPSv6.5 feed library for Canola Meal, Expeller

FIELD IMPLEMENTATION

The new methods and updated amino acid composition/efficiency values implemented in CNCPSv6.5 allow the nutritionist to explain more production and formulation variance. Implementing CNCPSv6.5 should be done step-wise by nutritionists. AMTS.Cattle.Professional ver. 4 fully implemented CNCPSv6.5. During the upgrade process, user files were converted to implement the new amino acid composition values. While this is an important step, and allows nutritionists to evaluate amino acids with the latest information and improved confidence, it is only the first step. The CNCPSv6.5, and AMTS, feed libraries have fields for the new DNDF time points, uNDF, and IUN results. These fields are not populated with data however. And, if data is not present, the programs utilize CNCPS6.1 calculations. Data limitations, and normal variance between farm/source, make it nearly impossible to populate these fields. As commercial products are analyzed, a feed library could be developed; however, this takes time and resources. It is estimated that it would require approximately $2 million USD in feed analysis to fully populate the existing library for these new methods.

The major commercial laboratories, along with their affiliates, introduced aNDFom early 2015 via NIR and wet chemistry. These laboratories have very good NIR calibrations for aNDFom on forages. Non-forages that could potentially be high in soil contaimination should be analyzed wet chemistry for aNDFom. These would include ingredients such as beets, cottonseed, cotton burrs, almond hulls, and other ingredients that would be prone to soil contact.

Moving towards uNDF is also recommended. Again, the aforementioned commercial laboratories and their affiliates began offering 30, 120, and 240hr DNDF via NIR in early/mid 2015. These results need to be reported, and inputted, as %NDFom. Diets high in non-forage NDF feeds should be analyzed for 12, 72, 120 hr DNDF as well.

Unfortunately, this must be done via wet chemistry. Given that greater then 70% of total CHO C comes from forages in typical diets, adopting the 30, 120, and 240hr DNDF is the most sensitive component. Feeds high in NDF, and less processed, should be next. Examples of these would be cottonseed, wheat middlings, canola meal, etc.

Implementing the Ross assay would be the final step with a focus on high protein feeds. The IUN assay is also the most difficult to implement. Attempting to implement this with only one or two feeds could greatly alter the perceived value of these feeds while optimizing or evaluating purchasing options. Implementing with only one or two feeds (e.g. an animal protein and a by-pass vegetable product) can be a powerful tool to evaluate product consistency and relative differences between products within class (e.g. two different animal protein sources) if the IUN is measured from both suppliers. It is recommended that IUN be implemented in two phases. The first phase would be high RUP products or those with known or suspected product variance (e.g. commodity blood meal, distillers grains, etc.). Within CNCPSv6.5 and AMTS, inputting IUN initiates several changes in the code. A user can input the IUN, evaluate the diet, and then input zero IUN and compare. During this time, a user feed library populated with IUN results can be developed. As additional feeds are added, formulation can become more IUN based. The second phase would be lower RUP feeds (e.g. soybean meal). Individual consultants are at a disadvantage here given their access to limited sample numbers. Consultant groups and feed companies should develop internal projects to develop a IUN based feed library. Regardless, nutritionists should request IUN results for commercial RUP products. Given the commercialization of the assay, it is now possible to include this as a standard quality control assay.

CONCLUSION

Modeling is an evolutionary process. The CNCPS has been able to capture research results and improve accuracy and formulation. Many times, these improvements introduce new inputs and outputs while forcing nutritionists to re-evaluate current thinking. The move from CNCPSv6.1 to CNCPSv6.5 biology is one of these re-evaluation points. Modern formulation packages and the commercial laboratories have worked closely together to ensure the new assays and biological modeling is implemented for nutritionists to take advantage of. Future model enhancements will allow nutritionists to evaluate dry matter intake differently and further fine-tune formulations. The CNCPSv6.5 is a step towards a fully dynamic supply model (CNCPSv7) and many CNCPSv7 concepts are introduced in CNCPSv6.5. AMTS user feedback supports implementing CNCPSv6.5 biology rapidly due to improved accuracy and the ability to improve animal performance.

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