TOTAL FATTY ACID AND RUMEN UNSATURATED FATTY ACID LOAD VARIATION IN COMMERCIAL TMR, FORAGES, AND CORN GRAIN

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INTRODUCTION:

- Milk fat depression in commercial dairy cattle carries substantial economic ramifications for most dairy farms
  - Many milk processors pay for milk fat content in addition to protein and other solids
  - Milk fat (butterfat) value has recently increased in value due to butter demand (John Guess; 2017 Milk Price blog; accessed online at http://milkprice.blogspot.com/2017/05/april-class-and-component-prices-down.html)
    - Butterfat is now contributing a greater percentage of income for dairy farm milk payments relative to protein and other solids
- Milk fat depression is likely due to multiple factors on farm, including diet
  - Risk of dietary-induced milk fat depression and troubleshooting low milk fat tests may be partially alleviated when the fatty acid (FA) content and profiles for individual feeds are known
  - Rumen unsaturated fatty acid load (RUFAL, g) may be related to milk fat losses
- This study's objective was to expand on feed library fatty acid concentration reference values
  - We sought to expand on feed library data by describing population statistics for total FA content (TFA, % DM) and rumen unsaturated FA load (RUFAL, % of TFA) for commercial dairy farm forages and corn grain within the United States
- Our secondary objective was to determine if knowing TFA and feed type was sufficient to predict RUFAL (% DM and % TFA)

METHODS:

- Commercial farm legume and/or grass hay (n=69) and silage (n=129), corn silage (n=115), corn grain (N=35), and small grain silages (n=46) were selected from samples submitted for routine forage analysis for further fatty acid analyses
  - The samples were selected from across the US based upon near-infrared spectral diversity
- Total FA concentration and profile was determined by gas-liquid chromatography (Lock et al., 2013)
  - TFA was calculated by summing individual FA (% of DM) concentrations
    - Only known fatty acids were included within the sum (Figure 1)
  - RUFAL (% of TFA) was determined by summing unsaturated 18-carbon FA.
    - RUFAL was expressed as both % DM and % TFA to explore the variation across feeds and within FA content
- Data were analyzed by SAS JMP Pro v11 (SAS Institute, Cary, NC) using a simple linear regression approach and the model builder function
  - RUFAL (% TFA and % DM) was related to TFA and feed type using backwards elimination model selection
  - Residuals were assessed for normality
- The data were also related to forage and corn grain near-infrared spectra by partial least squares method (WinISI v4.9, FOSS Analytical A/S, Hilleroed, Denmark)
  - An NIR calibration was developed to predict total fatty acid content in future, unknown, forage and corn grain samples

DISCUSSION:

- Population statistics for TFA and RUFAL are presented in Table 1
  - The variation can be visually assessed in Figure 2
- Total fatty acid values as measured and reported only take into account known fatty acids – an example chromatogram is presented in Figure 1
- RUFAL (% DM) was related to TFA (linear and quadratic effects), feed, and we noted a TFA interaction with feed (each with P<0.001; model adj. R2=0.99)
- RUFAL (% TFA) was related to TFA (linear and quadratic effects) and feed (each with P<0.001; model adj. R2=0.77)
- The coefficient of variation (percentage; Table 1) suggest that TFA varies greater than the FA profile.
  - This could be interpreted to mean that feed TFA should be considered first by nutritionists and then fatty acid profile considered second
- The NIR spectra relationship to total fatty acid measures was significant (P< 0.01) and calibration statistics presented in Table 2

Table 1: Commercial farm forage and grain population descriptive statistics for total fatty acid (TFA) and rumen unsaturated fatty acid load (RUFAL) determined by gas liquid chromatography.

	NIR PREDICTED NUTRIENTS, % OF DM		WET CHEMISTRY MEASURES							
Feed	Crude Protein	NDF	TFA Mean (%DM)	St. Dev.	Coeff. Var.	RUFAL Mean (%TFA)	St. Dev.	Coeff. Var.	RUFAL Mean (%DM)	St. Dev.
Legume/Grass Hay	17.58	49.62	0.92	0.26	27.9	52.3	7.03	13.5	0.49	0.17
Legume/Grass Silage	16.65	45.53	1.26	0.51	40.3	63.8	10	15.7	0.84	0.42
Corn Silage	7.49	43.07	1.54	0.32	20.6	75.2	4.62	6.1	1.18	0.29
Corn Grain	8.34	11.71	2.89	0.67	23.1	84.4	1.76	2.09	2.45	0.59
Small Grain Silage	12.72	53.25	1.11	0.4	35.6	64.7	9.17	14.2	0.74	0.32

Table 2: Near infrared reflectance spectroscopy calibration statistics for total fatty acid content (% of DM) determined from the set analyzed here.

Constituent	N	Mean	SD	Est. Min.	Est. Max	SEC	RSQ	SECV	1-VR	#
TFA	373	1.44	0.62	0	3.23	0.14	0.95	0.16	0.93	173

Figure 1: Fatty acid profile chromatogram example, where only known fatty acids are identified and summed to measure total fatty acid. The red arrow indicates an unknown peak which may be mistakenly interpreted as a fatty acid, but is not.

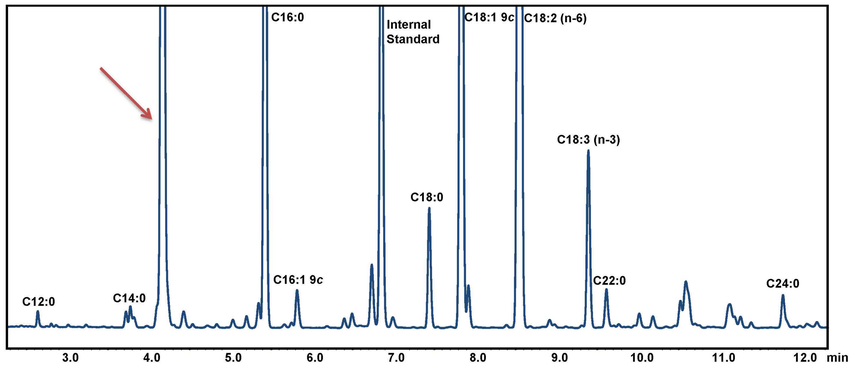
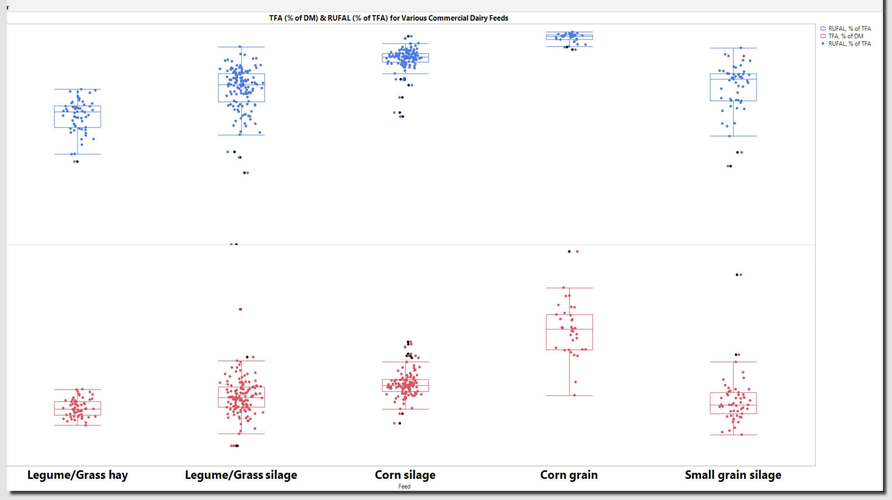


Figure 2: Commercial farm forage and grain box and whisker plots.



CONCLUSIONS:

- The population data presented here can be used to supplement prior feed library values and represent current commercial forages and corn grain in the United States
- Results suggest that feed TFA (% DM) can predict RUFAL (% DM), however relationships may not be linear and are feed dependent.
- Both TFA and RUFAL demonstrated considerable coefficients of variation
  - Both should be considered when practicing fatty acid nutrition for dairy cattle and when troubleshooting milk fat depression
  - For example, the variation in corn silage RUFAL concentration observed in this set could account for a range of more than 170 g RUFAL (% of DM) per cow per day; assuming corn silage was fed at 9.5 kg per cow per day:
    - Minimum RUFAL (% of DM) contribution from corn silage - 28.5 g (0.3% RUFAL, % of DM; minimum observed in this set)
    - Maximum RUFAL (% of DM) contribution from corn silage - 203.3 g (2.15% RUFAL, % of DM; maximum observed in this set)

REFERENCES:

Lock, A.L., C.L. Preseault, J.E. Rico, K.E. DeLand, and M.S. Allen. 2013. Feeding a C16:0-enriched fat supplement increased the yield of milk fat and improved conversion of feed to milk. J. Dairy Sci. 96:6650–6659. doi:10.3168/jds.2013-6892