# Total Tract NDF Digestion predicted using rumen in vitro measures is related to commercial dairy in vivo total tract nutrient digestion

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## Introduction:

- Dairy cattle in vivo total tract organic matter (OM) and NDF digestion estimates have been correlated to animal performance (Oba & Allen, 2012; Schalla et al., 2012).
  - Digestion measures vary widely and below average performance in certain areas can be used to formulate alternative nutrition programs.
- TMR in vivo digestion results can be used in the field to assess opportunities to improve dairy performance.
  - Examples include total tract starch digestion assessed using lignin as an indigestible marker (Ferguson, unpublished)
- Measuring in vivo digestion on commercial farms, however, is time consuming and costly relative to other nutritional measures.
  - Fecal starch content (% DM) has been related to total tract digestion (Ferguson, unpublished; Ferraretto et al., 2012), however other nutrients are difficult to predict using simple analysis measures.
- Combs (2013) developed an additional approach to predict in vivo total tract NDF digestion (TTNDFD) performance based on in vitro rumen measures.

## Objective:

Our objective was to determine if total tract NDF digestion estimates predicted using rumen in vitro data (TTNDFD) were related to in vivo apparent total tract organic matter (OM) and carbohydrate digestion coefficients.

## Materials and Methods:

- Commercial dairy Total Mixed Ration (TMR) samples (n=50) submitted to Rock River Laboratory, Inc. (Watertown, WI) for in vivo digestion analysis, were selected for further evaluation.
  - Further analyses included rumen in vitro digestion using Goeser et al. (2009) technique.
  - Samples dried and ground to pass a 1mm Udy Mill screen and digested in duplicate for 24, 30 and 48 h.
- In vivo OM and carbohydrate digestion coefficients [OM, NDF, potentially digestible NDF (pdNDF) and starch, % of nutrient] were determined using 120 h iNDF as an internal marker (Schalla et al., 2012).
  - TMR potentially digestible NDF (pdNDF, % of NDF) was also estimated using the 120 h NDFD measures.
- NDF $K_d$ was calculated using log-linear transformed 24, 30, and 48h undigested NDF residues, 13 h lag and pdNDF.
- TTNDFD was predicted using the $k_d / (k_d + k_p)$ equation and assuming a constant post-ruminal digestion.
  - The $k_p$ used was based on NDF passage predicted by Combs (2013) using the Krizsan et al. (2012) equation.
- TMR nutrient content and in vivo digestion coefficient descriptive statistics were calculated.
- TTNDFD estimates were regressed on in vivo OM, NDF, pdNDF, and starch digestion coefficients using SAS JMP Pro v11.0.
  - Residuals were assessed for normality

## Results and Discussion:

- TTNDFD was significantly (P<0.01) related to OMD, NDFD, and pdNDFD.
- The regression equation parameter results are outlined in Table 1.
  - Each 1 unit increase in TTNDFD was related to:
    - 0.56 unit improvement with in vivo OM digestion
    - 1.01 unit improvement with in vivo NDF digestion
    - 1.01 unit improvement with in vivo pdNDF digestion
- Results suggest logical agreement between NDFD measures
- TTNDFD model descriptive statistics for 50 TMRs analyzed are outlined in Table 2.

**Table 1: TMR nutrient and digestion coefficient descriptive statistics and regression model parameters in relation to TTNDFD. Results followed by * or ** differ from zero (P<0.05 and P<0.01, respectively).**

| | OM | NDF | pdNDF | Starch |
|---|---|---|---|---|
| **TMR Nutrient Content (% of DM)** | | | | |
| **Mean** | 92.01 | 31.93 | 19.30 | 25.15 |
| **St. Dev.** | 1.03 | 3.740 | 3.22 | 4.04 |
| **in vivo Digestion Coefficient (% of Nutrient)** | | | | |
| **Mean** | 58.82 | 37.80 | 61.88 | 94.73 |
| **St. Dev.** | 9.45 | 11.14 | 14.62 | 4.66 |
| **Regression Model Parameters in Relation to TTNDFD** | | | | |
| **Intercept** | 38.50** | 1.09 | 24.98** | 92.36* |
| **Slope** | 0.56** | 1.01** | 1.01** | 0.07 |
| **$R^2$** | 0.14 | 0.30 | 0.18 | 0.01 |
| **RMSE** | 8.86 | 9.39 | 13.38 | 4.68 |

- These data demonstrate a significant relationship between TTNDFD predictions and in vivo total tract digestion measures.
  - Results offer validation and suggest that the TTNDFD in vitro approach can predict in vivo digestion.
- While relationships were significant, $R^2$ and RMSE suggest that continued evaluation is warranted.

**Figure 1: Commercial dairy cattle in vivo total tract NDF digestibility (% of NDF) raw data plotted against in vitro predicted total tract NDF digestibility (TTNDFD, % of NDF) for 50 commercial TMR samples and linear regression line (R2 = 0.30, RMSE = 9.39)**

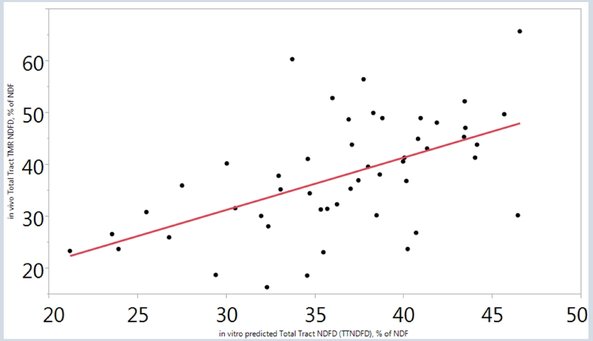


**Table 2: Total Mixed Ration nutrient and in vitro TTNDFD digestion measure descriptive measures for 50 samples analyzed**

| Parameter | NDF $k_d$ | pdNDF, % of NDF | TTNDFD |
|---|---|---|---|
| **Mean** | 4.27 | 60.36 | 36.13 |
| **St. Dev.** | 1.57 | 6.12 | 6.24 |

## Conclusions:

On commercial dairies, in vitro TTNDFD measures may be an additional tool to help identify TMR nutrition and performance opportunities.

References:

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