Forage In Vitro NDF Digestibility and Intake, Digestion and Milk Production by Dairy Cows

Randy Shaver

Professor and Extension Dairy Nutritionist
Department of Dairy Science
College of Agricultural and Life Sciences
University of Wisconsin – Madison
University of Wisconsin – Extension

Introduction

A symposium, *"Identifying Opportunities for Maximizing Forage Utilization"*, was held during the 2006 ADSA/ASAS Annual Meeting. My talk there, *"Forage intake, digestion and milk production by dairy cows"* (Shaver, 2006), can be viewed or downloaded at http://www.wisc.edu/dysci/uwex/nutritn/presentn/adsasmn06symposium.pdf. That review, which focused primarily on the relationship between lactation performance of dairy cows and in vitro NDF digestibility (IVNDFD) of forages, will serve as the basis for my presentation at the PNWANC. The purpose of this paper is to provide a text summary and reference list for the talks presented at 2006 ADSA/ASAS and PNWANC Meetings.

Review Summary

- Lactation performance was best for diets that averaged 64% alfalfa silage (DM basis) across lactation (48, 58, and 78% alfalfa silage diets for the 1st, 2nd, and 3rd trimester of lactation, respectively) in a comparison of five diets that averaged from 53% to 98% alfalfa silage (DM basis) across lactation (Tessman et al., 1991). But, no attempt was made to optimize the quality of alfalfa silage used in the study and IVNDFD was not considered. Dhiman and Satter (1997) concluded that a forage mixture of 1/3rd or 2/3rd corn silage (DM basis) gave improved lactation performance compared to an all alfalfa silage based diet. But, no attempt was made to maximize the percentage forage in the diet or optimize the quality of forages used the study and IVNDFD was not considered.

- DMI and milk or FCM yield were increased for high vs. low IVNDFD alfalfa silages of similar NDF content (Dado and Allen, 1996), and for early vegetative (low NDF, high In Situ NDFD) vs. full bloom (high NDF, low ISNDFD) alfalfa hays even though concentrates comprised only 38% of the early-cut versus 55% of the late-cut hay diets (Llamas-Lamas and Combs, 1990). Mertens et al. (2005) and Raeth-Kinght et al. (2005) fed alfalfa hays (30 or 15% of diet DM in each report, respectively) that contained either low NDF (36 to 37% of DM) of "varying" IVNDFD (38 to 41% of NDF) or "high" NDF (41 to 42% of DM) of "varying" IVNDFD (41 to 45% of NDF).

Milk yield was not increased by the "higher" IVNDFD alfalfa hays, but this lack of response to IVNDFD could likely have been expected a priori given the small IVNDFD differences between the hays and the low NDF content of the hays.

- ❖ DMI and milk yield were increased for high vs. low IVNDFD corn silages of similar NDF content in studies comparing bm_3 versus isogenic hybrids (Oba and Allen, 2000; Oba and Allen, 1999). Milk fat test was reduced for cows fed bm_3 corn silage in 42% but not 65% forage diets (DM basis; Oba and Allen, 2000). Solids-corrected milk yield was 1.1 or 3.2 kg/d higher for cows fed bm_3 corn silage in 35% concentrate diets than the isogenic control in 58% or 35% concentrate diets, respectively (DM basis; Oba and Allen, 2000). Bal et al. (2000) reported similar DMI and milk yield with increased milk fat test for cows fed bm_3 corn silage in 61% forage diets versus a conventional hybrid in 48% forage diets (DM basis). DMI and FCM yield were increased for high NDF, high IVNDFD corn silage versus moderate NDF, moderate IVNDFD corn silage (Ivan et al., 2005). Oba and Allen (1999) and Ivan et al. (2005) reported greater FCM yield responses to corn silage IVNDFD for cows with higher pre-trial milk yields. Apparent total-tract OM digestibility was not increased for high IVNDFD bm_3 corn silages (Oba and Allen, 2000; Oba and Allen, 1999; Ivan et al., 2005). Tine et al. (2001) reported greater DE, ME, and NE values for bm_3 corn silage than the isogenic control in dry cows fed at maintenance, but not in lactating cows fed at 4x maintenance. Increased milk yield with higher IVNDFD bm_3 corn silages was related primarily to an increase in DMI (Oba and Allen, 2000; Oba and Allen, 1999; Ivan et al., 2005).

- ❖ DMI and FCM yield were higher for forages with higher ISNDFD (corn silage and dwarf elephant grass silage) than for those with lower ISNDFD (Tifton bermudagrass silage and sorghum silage) (Ruiz et al., 1995).
- ❖ Feeding brown midrib sorghum silage with higher IVNDFD or ISNDFD than a conventional sorghum hybrid increased DMI and FCM yield in four trials from three reports (Aydin et al., 1999; Grant et al., 1995; Oliver et al., 2004). Similar DMI and FCM yield was observed for BMR sorghum silage versus corn or alfalfa silages in some cases.

- ❖ Milk yield was increased for early cut (high ISNDFD) vs. late-cut (low ISNDFD) wheat silages of similar NDF content (Arieli and Adin, 1994). Ammoniating wheat straw increased IVNDFD and FCM yield at two concentrations of dietary NDF (8.5 or 16% wheat straw diets; Kendall and Combs, 2004). Increased IVNDFD of barley silage increased body weight gain of late lactation cows, but not DMI or milk yield.

Conclusions and Perspectives

- ❖ > IVNDFD has been related to > milk production across an array of forages.
- ❖ Milk production response to IVNDFD thru DMI, not digestibility or energy density.

- ❖ DMI & milk production responses to IVNDFD > in higher producing cows.

- ❖ Benefits of BMR corn & sorghum silages for IVNDFD, DMI, and milk production have been observed consistently.

- ❖ More IVNDFD/in vivo research needed with legumes & other grasses.
- ❖ Single time-point incubations unlikely to predict in vivo differences between legumes & grasses – i.e. rate vs. extent of NDF digestion differences (Hoffman et al., 1993).

- ❖ IVNDFD has not been fully exploited in trials attempting to maximize dietary forage or optimize forage mixtures.

Literature Cited

Arieli, A., and G. Adin. 1994. Effect of wheat silage maturity on digestion and milk yield in dairy cows. J. Dairy Sci. 77: 237-243.

Aydin, G., R. J. Grant, and J. O'rear. 1999. Brown midrib sorghum in diets for lactating dairy cows. J. Dairy Sci. 82: 2127-2135.

Bal, M. A., R. D. Shaver, H. Al-Jobeile, J. G. Coors, and J. G. Lauer. 2000. Corn silage hybrid effects on intake, digestion, and milk production by dairy cows. J. Dairy Sci. 83: 2849-2858.

Chow, L., M. Oba, V. Baron, and R. Corbett. 2006. Effects of advanced in vitro fiber digestibility of barley silage on dry matter intake and milk yield of dairy cows. J. Dairy Sci. 89(Suppl.1):263(Abstr.).

Dado, R. G., and M. S. Allen. 1996. Enhanced intake and production of cows offered ensiled alfalfa with higher neutral detergent fiber digestibility. J. Dairy Sci. 79: 418-428.

Dhiman, T. R., and L. D. Satter. 1997. Yield response of dairy cows fed different proportions of alfalfa silage and corn silage. J. Dairy Sci. 80: 2069-2082.

Grant, R. J., S. G. Haddad, K. J. Moore, and J. F. Pedersen. 1995. Brown midrib sorghum silage for midlactation dairy cows. J. Dairy Sci. 78: 1970-1980.

Hoffman, P. C., S. J. Sievert, R. D. Shaver, D. A. Welch, and D. K. Combs. 1993. In situ dry matter, protein, and fiber degradation of perennial forages. J. Dairy Sci. 76: 2632-2643.

Kendall, C., and D. K. Combs. 2004. Intake and milk production of cows fed diets that differed in dietary NDF and NDF digestibility. J. Dairy Sci. 87(Suppl.1):340(Abstr.).

Ivan, S. K., R. J. Grant, D. Weakley, and J. Beck. 2005. Comparison of a Corn Silage Hybrid with High Cell-Wall Content and Digestibility with a Hybrid of Lower Cell-Wall Content on Performance of Holstein Cows. J. Dairy Sci. 2005 88:244-254.

Llamas-Lamas, G., and D. K. Combs. 1990. Effect of Alfalfa Maturity on Fiber Utilization by High Producing Dairy Cows. J. Dairy Sci. 73: 1069-1080.

Mertens, D. R., H. G. Jung, M. L. Raeth-Knight, and J. G. Linn. 2005. Impact of alfalfa hay neutral detergent fiber concentration and digestibility on Holstein dairy cow performance: I. Hay analyses and lactation performance – USDFRC. J. Dairy Sci. 88(Suppl.1):250(Abstr.).

Oba, M. and M. S. Allen. 2000. Effects of brown midrib 3 mutation in corn silage on productivity of dairy cows fed two concentrations of dietary neutral detergent fiber: 1. Feeding behavior and nutrient utilization. J. Dairy Sci. 83:1333-1341.

Oba, M. and M. S. Allen. 1999. Effects of brown midrib 3 mutation in corn silage on dry matter intake and productivity of high yielding dairy cows. J. Dairy Sci. 82:135-142.

Oliver, A. L., R. J. Grant, J. F. Pedersen, and J. O'Rear. 2004. Comparison of brown midrib-6 and -18 forage sorghum with conventional sorghum and corn silage in diets of lactating dairy cows. J. Dairy Sci. 87: 637-644.

Raeth-Knight, M. L., J. G. Linn, H. G. Jung, D. R., Mertens, and P. R. Peterson. 2005. Impact of alfalfa hay neutral detergent fiber concentration and digestibility on Holstein dairy cow performance: II. Lactation performance – St. Paul. J. Dairy Sci. 88(Suppl.1):250(Abstr.).

Ruiz, T. M., E. Bernal, C. R. Staples, L. E. Sollenberger, and R. N. Gallaher. 1995. Effect of dietary neutral detergent fiber concentration and forage source on performance of lactating cows. J. Dairy Sci. 78: 305-319.

Shaver, R. D. 2006. Forage intake, digestion and milk production by dairy cows. J. Dairy Sci. 89(Suppl.1):298(Abstr.).

Tessmann, N. J., H. D. Radloff, J. Kleinmans, T. R. Dhiman, and L. D. Satter. 1991. Milk production response to dietary forage:grain ratio. J. Dairy Sci. 74: 2696-2707.

Tine, M. A., K. R. Mcleod, R. A. Erdman, and R. L. Baldwin, VI. 2001. Effects of brown midrib corn silage on the energy balance of dairy cattle. J. Dairy Sci. 84: 885-895.