Italian Journal of Animal Science

ISSN: (Print) 1828-051X (Online) Journal homepage: https://www.tandfonline.com/loi/tjas20

# Innovative procedures to evaluate corn silage for milk yield

M. Spanghero & C. Zanfi

**To cite this article:** M. Spanghero & C. Zanfi (2005) Innovative procedures to evaluate corn silage for milk yield, Italian Journal of Animal Science, 4:sup2, 150-152, DOI: 10.4081/ijas.2005.2s.150

**To link to this article:** https://doi.org/10.4081/ijas.2005.2s.150

# Innovative procedures to evaluate corn silage for milk yield

M. Spanghero, C. Zanfi

Dipartimento Scienze Animali, Università di Udine, Italy

*Corresponding author:* Mauro Spanghero. Dipartimento Scienze Animali. Via S. Mauro 2, 33010 Pagnacco, Italy – Tel: +39 0432 650110 – Fax: +39 0432 660614 – Email: mauro.spanghero@dspa.uniud.it.

**RIASSUNTO** – Procedure innovative di valutazione del silomais per la produzione di latte. *Su 58 campioni di silomais sono stati misurati i principali costituenti chimici e la degradabilità ruminale in vitro dell'NDF (NDFd) per stimare il contenuto in energia netta di lattazione (ENl) e la potenziale produzione di latte utilizzando un modello di previsione dell'ingestione basato sul contenuto e la degradabiità dell'NDF. La NDFd è risultata pari a 51±5% e la variabilità dei valori calcolati di ENl va ascritta per il 50-60% alle variazioni di NDFd e al 30-40% alle diverse frazioni dei carboidrati. Le differenze in produzione di latte (19%) sono in prevalenza attribuibili alla variabilità dell'NDFd (dal 55 al 61%). L'elevato contributo dell'NDFd alle variabilità suggerisce una verifica in vivo dei range di variazione ottenibili in vitro.*

**Key words**: in vitro degradability, NDF, net energy of lactation, intake.

**INTRODUCTION** – Corn silage is the main ingredient of diets for dairy cattle (around 40% of diet DM in Italy) and, therefore, an accurate estimation of its nutritive value is essential to describe the whole diet. Given the low, and fairly stable protein, lipid and ash contents in corn silage (e.g. a total of around 15% DM), the critical point to evaluate its energy value is the amount and availability of the two main carbohydrate fractions (NDF and non fiber carbohydrates, NFC). NDF is the largest fraction in corn silage (45-50% DM) and has variable rumen degradability (Lauer *et al.*, 1997; Ishler and Varga, 2001) which affects its energetic value and its intake (Oba *et al.*, 1999). Cheap and fast in vitro techniques are now available to allow a routinary NDFd measurement (Robinson *et al.*, 1999). The remaining carbohydrates (NFC, 40-45% DM) have a high total tract utilization, which is assumed almost complete (98%) by NRC (2001) or moderately variable by Schwab *et al.*, 2003. The objective of the present trial is to study the impact of some main carbohydrate fractions and their digestive utilization on nutritive value of corn silage in terms of net energy of lactation content and milk yield according to NRC (2001) and Schwab *et al.* (2003) procedures.

**MATERIAL AND METHODS** – 58 samples of corn silage collected during spring 2004 in dairy farms (Po Valley, North Italy), were analysed for DM, ash, CP, NDF, EE and starch (S). Each sample was also tested in triplicate for the in vitro NDFd according to Robinson *et al.* (1999). In brief, dried and milled sample (250 mg) was introduced in filter bags, which were placed in digestion jars filled with pre-warmed (39°C) buffer solutions and rumen inoculum collected from two rumen cannulated cows fed at maintenance. Four jars (24 bags/jar) were then inserted into a Daisy incubator (Ankom, Tech. Co., Fairport, NY, USA) for 48 h.

*ENl calculations* – For each sample, the chemical contents (% DM), NDFd (%) and total tract digestibility of starch (STTD,%) were used to estimate the following individual digestible nutrients contents (% DM):

Dig. CP = (CP x 0.93); Dig. EE = [(EE - 1) x 0.97 x 2.25]; Dig. NDF = (NDF x NDFd);
Dig. S = (S x STTD); Dig. NFC = (NFC x 0.98) Dig. Non-starch NFC = [(NFC-S) x 0.98]

The STTD was calculated from the whole plant DM content (WPDM,g/Kg, Schwab *et al.* 2003):

| | | |
|---|---|---|
| Processed with a roller mill at harvest | STTDp | = 1.19 - (0.00081 * WPDM) |
| Unprocessed | STTDu | = 1.34 - (0.00135 * WPDM) |

The ENl (Mcal/kg) was finally calculated with the following equations:

"NRC (2001)" = [(dig. CP + dig. EE + dig. NDF + dig. NFC - 7) x 0.0245] - 0.12

"Schwab *et al.* (2003)" = [(dig. CP + dig. EE + dig. NDF + dig. S + dig. (NFC-S) -7) x 0.0245] – 0.12

*The intake model* - The daily corn silage intake was estimated from:
- NDF silage content: assuming that corn silage represents 50% of the total NDF intake of cows (1.15% of body weight (BW), BW: 612 Kg, Schwab *et al.*, 2003);
- NDFd silage: assuming that each percentage of NDFd variation with respect to the average value (51.1% in present dataset) induced an intake variation of 0.17 kg/d (Oba *et al.*, 1999);

Corn silage DMI (kg/d) = [(612 * 1.15 * 0.50) / (NDF/100)] + [(NDFd - 51.1) * 0.17]

*Milk yield calculations* - The expected daily milk yield (MY, 680 kcal/kg) was predicted as follows:

MY (kg/d) = (A - B) / 680

where A was the amount of net energy supplied by corn silage (Kcal/d) and B was the cow maintenance requirement (9800 kcal ENl/d) proportioned according to the concentration of corn silage in the diet and assuming (30% of total dietary NDF; (Schwab *et al.*, 2003).

ENl and MY were used as dependent variables in a multiple regression step-wise model (NDFd, STTD and main chemical fractions as independent variables).

**RESULTS AND CONCLUSIONS** – The set of corn silage samples has a typical chemical composition (Table 1). Present experimental measure of in vitro NDFd varies from 39 to 62% (51.1±5.3%) and this range is comparable to those reported by Ishler and Varga (2001; 25-62%), Shaver *et al.* (2003; 43-82%) and Lauer *et al.* (1997; 40-53%).

The ENl content, according to NRC (2001), is slightly higher than that published for medium maturity products (1579 *vs.* 1450 kcal/kg DM) and than those calculated according to Schwab *et al.*, 2003 (1504-1530 kcal/kg DM). This latter difference, is because to the starch fraction is attributed a lower digestibility than the non-starch NFC (from 72 to 97% *vs.* 98%). The overall ENl variability (4%) is considerably lower than that of the main chemical fractions.

Table 1. Simple statistics of chemical composition, carbohydrates digestive utilisation, ENl and expected milk yield.

| | | Average | s.d. | Range | c.v. (%) |
|---|---|---|---|---|---|
| Chemical composition | | | | | |
| - DM | % | 33.9 | 3.1 | 27.6-43.0 | 9 |
| - NDF | % DM | 43.1 | 3.7 | 35.1-52.6 | 8 |
| - Starch | " | 30.6 | 4.3 | 17.2-37.6 | 14 |
| - NFC (100-(NDF-$NDF_{cp}$+EE+CP+Ash) | " | 43.4 | 3.8 | 34.8-51.6 | 9 |
| - NFCns (NFC-Starch) | " | 12.8 | 2.6 | 6.4-18.6 | 20 |
| - CP + EE + ash | " | 14.8 | 0.5 | 13.2-15.8 | 3 |
| Carbohydrates digestive utilisation | | | | | |
| - NDFd | % | 51.1 | 5.3 | 38.7-62.4 | 10 |
| -STTD unprocessed | " | 88.2 | 4.1 | 76.0-96.7 | 5 |
| -STTD processed | " | 91.5 | 2.5 | 84.2-96.6 | 3 |
| NRC, 2001 | | | | | |
| - Enl | Kcal/kg DM | 1579 | 66 | 1441-1746 | 4 |
| - Milk yield | Kg/d | 14.1 | 2.6 | 9.8-21.8 | 18 |
| Schwab *et al.*, 2003 - unprocessed | | | | | |
| - Enl | Kcal/kg DM | 1504 | 65 | 1357-1658 | 4 |
| - Milk yield | Kg/d | 13.2 | 2.5 | 8.7-20.3 | 19 |
| Schwab *et al.*, 2003 - processed | | | | | |
| - Enl | Kcal/kg DM | 1530 | 63 | 1398-1688 | 4 |
| - Milk yield | Kg/d | 13.5 | 2.5 | 9.1-20.8 | 19 |

$NDF_{cp}$: a constant value of 1.4% DM was assumed.

In the assumptions of our calculations (ENl, intake and milk/cows characteristics), the allowed milk production averages between 13 and 14 kg per day. As expected when the NDF content and the NDFd are used to differentiate the samples also in terms of DMI, this generates a wide variability in MY (19% CV), with values varying from 9 to 22 kg/d of milk. The simple correlation analysis (data not shown) have revealed the absence of correlation between NDF content and NDFd, while an expected high relationship has found between NDF and starch contents (correlation coefficient: -0.791). In table 2 we have ranked the main chemical fractions, the NDFd and the STTD values in terms of contribution (partial $R^2$: $r^2_p$) to total variability of estimated ENl contents and milk yields.

Table 2. Contribution of NDFd, STTD and the main chemical fractions on overall ENl and milk yield (MY) variability (partial correlation coefficient, $r^2_p$,%).

| | Carbohydrates | | | | | | Non[1] carbohydrates |
|---|---|---|---|---|---|---|---|
| | Fibrous | | Non fibrous | | | | |
| | NDF | $NDF_d$ | NFC | Starch | STTD | $NFC_{ns}$ | |
| - ENl - NRC, 2001 | <1 | 50 | 48 | – | – | – | < 1 |
| - ENl - Schwab *et al.*, 2003[u] | 22 | 62 | - | < 1 | 13 | < 1 | < 1 |
| - ENl - Schwab *et al.*, 2003[p] | 33 | 62 | - | < 1 | 3 | < 1 | < 1 |
| - MY - NRC, 2001 | <1 | 55 | 44 | – | – | – | < 1 |
| - MY - Schwab *et al.*, 2003[u] | 37 | 61 | - | < 1 | <1 | < 1 | < 1 |
| - MY - Schwab *et al.*, 2003[p] | 39 | 60 | - | < 1 | <1 | < 1 | < 1 |

[1]: protein, ether extract, ash, NFCns: see table 1.

The NDFd is the main contributor to total variability of ENl contents ($r^2_p$: 50-62%) and it is followed by the NFC content ($r^2_p$: 48%) in the NRC (2001) procedure or the NDF content ($r^2_p$: 22-33%) in the two Schwab *et al.* (2003) models. The contribution of starch digestibility has a limited impact ($r^2_p$: 13%) only in the case of the unprocessed silage and the overall variability is unaffected by the non-carbohydrates fraction, as well as by the starch content ($r^2_p$ <1%). Adopting the above described model to differentiate the intake, the expected milk yield variability is largely explained by variations in the NDFd ($r^2_p$: 55-61%), while lower contributes are given by the NFC fraction (44%, NRC, 2001) or by the NDF content (37-39%, Schwab *et al*, 2003).

In conclusion, our simulations based on the examined set of samples, have surprisingly shown that the NDFd has the greatest impact on determining the ENl and MY variability. A general assumption in the models considered is a direct application of in vitro NDFd to in vivo conditions. However such an application requires to be better investigated in terms of regression in vitro/in vivo to exclude any possible overestimation in the variability of the NDFd measured in vitro, which could mask the contribution of other factors (other chemical fractions and starch digestibility).

**ACKNOWLEDGEMENTS** – Financial support was provided by M.I.U.R. (P.R.I.N. 2003) and by Cortal S.p.A. (Cittadella, PD).

**REFERENCES** – **Ishler**, V., Varga, G., 2001. Carbohydrate nutrition for lactating dairy cattle. DASPennstate. http://www.das.psu.edu. **Lauer**, J., Kohn, K., Flannery, P., Hudelson, K., 1997. Wisconsin Corn Hybrid Performance Trials Grain and Silage. Univ. WI Extension. Madison. Home page address: http://corn.agronomy.wisc.edu. **National Research Council**, 2001. Nutrient Requirements of Dairy Cattle, seventh ed. (revised). National Academy of Sciences, Washington, DC. **Oba**, M., Allen, M.S., 1999. Evaluation of the importance of the digestibility of neutral detergent fiber from forage: effects on dry matter intake and milk yield of dairy cows. J. Dairy Sci. 82, 589-596. **Robinson**, P.H., Campbell, M., Fadel, J.G., 1999. Influence of storage time and temperature on in vitro digestion of neutral detergent fibre at 48 h, and comparison to 48 h in sacco neutral detergent fibre digestion. Anim. Feed Sci. Technol. 80, 257-66. **Schwab**, E., Shaver, R., Lauer, J., Coors, J., 2003. Estimating silage energy value and milk yield to rank corn hybrids. Anim. Feed Sci. Technol. 109, 1-18. **Shaver**, R., Undersander, D., Schwab, E., Hoffman, P., Lauer, J., Combs, D., Coors, J., Milk 2000: Combining Yield and Quality into a Single Term. http://www.uwex.edu.