# Effects of bag pore size and sample particle size on feed and fecal indigestible neutral detergent fiber concentration in dairy cows

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## INTRODUCTION

- Indigestible NDF (iNDF) is defined as plant cell wall carbohydrate which cannot be broken down by the ruminal microbes even after an infinite period (Mertens, 1993)
- iNDF describes the innate properties of the cell wall and serves as an ideal nutritional entity because its digestibility is zero (Mertens, 1993)
- iNDF has been used as an internal marker when measuring total-tract digestibility (Huhtanen et al., 1994)
- The accuracy and precision of iNDF estimates are dependent on the incubation technique utilized with, bag type and incubation length (Nocek, 1988)
- The recommended methodology is to use 288 h incubation and bags of 6 to 12 µm porosity (Krizsan and Huhtanen, 2013)
- Commercially available ANKOM F57 filter bags (25 µm pores size) and in situ bags (50 µm) were used for the determination of iNDF concentration. However, particle loss due to bag porosity is a potential source of error when incubating heterogeneous particle sizes for a long period (Huhtanen et al., 1994)

## OBJECTIVES

- To evaluate effects of bag porosity [nylon bags (15 µm); F57 bag (25 µm) and in situ bag (50 µm)] and sample particle size (1 mm and 2 mm) on the precision of iNDF concentration estimate of feed and feces of dairy cows.

## MATERIALS & METHODS

- Two cannulated lactating cows were fed diets containing alfalfa silage, corn, distillers grain, canola meal and soyhulls
- Feeds evaluated included:
  - Forage:
    - ✓ Alfalfa silage (AS)
    - ✓ Corn silage (CS)
    - ✓ Grass hay (GH)
    - ✓ Wheat straw (WS)
  - Byproducts:
    - ✓ Canola meal (CM)
    - ✓ Soybean meal (SBM)
    - ✓ Soy plus (SP)
    - ✓ Soyhulls (SH)
  - Four TMRs: 20%, 40%, 60% and 80% concentrate
  - Fecal samples (1 mm sample particle size): the same cows fed high-starch diet (FSHS) and fed low-starch diets (FSLS)
- Bag dimensions: 5 cm x 5 cm
- Samples were incubated 288 h in the rumen
- 3 x 2 factorial arrangements:
  - ✓ There bag pore size: 15 µm (BS15), 25 µm (BS25) and 50 µm (BS50).
  - ✓ Two samples particle size: 1 mm (PS1) and 2 mm (PS2)

## RESULTS

**Table 1** Chemical compositions of tested feed and fecal samples

| Items / % DM | DM | OM | CP | NDF |
|---|---|---|---|---|
| **Forage** | | | | |
| Alfalfa silage | 41.9 | 89.1 | 21.2 | 38.3 |
| Corn silage | 30.1 | 94.5 | 8.20 | 42.0 |
| Grass hay | 92.3 | 92.1 | 11.0 | 62.0 |
| Wheat straw | 85.0 | 91.7 | 3.93 | 78.5 |
| **Byproducts** | | | | |
| Canola meal | 91.0 | 92.6 | 40.9 | 22.6 |
| Soybean meal | 90.3 | 93.2 | 50.5 | 7.39 |
| Soy hulls | 90.5 | 95.5 | 11.6 | 69.2 |
| Soy Plus | 88.6 | 92.8 | 46.6 | 17.6 |
| **Fecal samples** | | | | |
| FSLS | 92.1 | 84.8 | 15.9 | 49.4 |
| FSHS | 91.6 | 87.2 | 17.9 | 49.2 |

**Table 2** Dietary ingredients and chemical compositions of TMRs

| Items | 20% | 40% | 60% | 80% |
|---|---|---|---|---|
| Ingredients (% of diet DM) | | | | |
| Alfalfa silage | 40.0 | 30.0 | 20.0 | 10.0 |
| Corn silage | 40.0 | 30.0 | 20.0 | 10.0 |
| Concentrate mix | 18.0 | 38.0 | 58.0 | 78.0 |
| Minerals | 2.00 | 2.00 | 2.00 | 2.00 |
| Chemical composition | | | | |
| DM (%) | 43.5 | 52.7 | 61.8 | 71.0 |
| OM (% DM) | 92.7 | 93.6 | 94.5 | 95.4 |
| CP (% of DM) | 15.1 | 15.9 | 16.7 | 17.5 |
| NDF (% of DM) | 35.7 | 31.8 | 27.8 | 23.8 |
| ADF (% of DM) | 26.8 | 23.7 | 20.6 | 17.6 |
| Ether Extract (% of DM) | 3.51 | 3.59 | 3.67 | 3.75 |

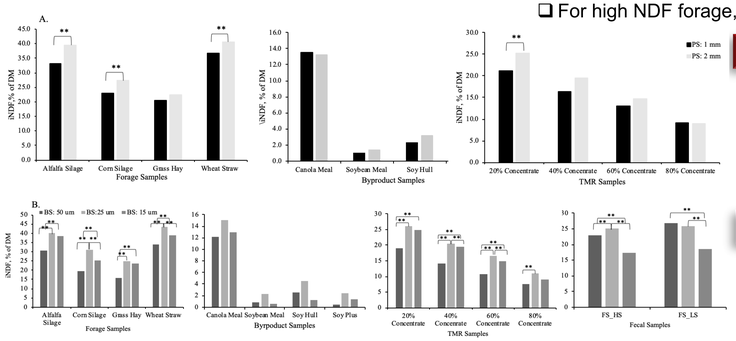


**Figure 1** Effects of particle size (A.) and bag size (B.) on the indigestible NDF concentration (%DM) of feed and fecal samples. **:*P* < 0.01.

**Table 3** Effects of bag size and particle size on the indigestible NDF concentration (% of DM) of feed and fecal samples

| Items | Bag size = S | | Bag size = M | | Bag size = L | | SEM |
|---|---|---|---|---|---|---|---|
| | Particle size = S | Particle size = L | Particle size = S | Particle size = L | Particle size = S | Particle size = L | |
| **Forages** | | | | | | | |
| Alfalfa Silage | 35.4$^{b}$ | 41.7$^{a}$ | 36.9$^{b}$ | 42.8$^{a}$ | 27.3$^{c}$ | 34.0$^{b}$ | 0.83 |
| Corn Silage | 22.4$^{c}$ | 27.8$^{b}$ | 29.8$^{b}$ | 32.6$^{a}$ | 17.2$^{d}$ | 22.0$^{c}$ | 0.83 |
| Grass Hay | 23.4$^{a}$ | 24.1$^{a}$ | 23.9$^{a}$ | 25.7$^{a}$ | 14.1$^{b}$ | 17.6$^{b}$ | 0.83 |
| Wheat Straw | 37.5$^{b}$ | 40.4$^{a}$ | 42.1$^{a}$ | 44.0$^{a}$ | 30.8$^{c}$ | 37.1$^{b}$ | 0.83 |
| **Byproducts** | | | | | | | |
| Canola Meal | 13.2$^{ab}$ | 12.5$^{b}$ | 15.3$^{a}$ | 14.8$^{a}$ | 12.0$^{b}$ | 12.4$^{b}$ | 0.43 |
| Soybean Meal | 0.28 | 0.85 | 2.33 | 2.27 | 0.51 | 1.17 | 0.43 |
| Soy Hull | 0.17$^{c}$ | 2.30$^{b}$ | 4.38$^{a}$ | 4.54$^{a}$ | 2.43$^{b}$ | 2.64$^{b}$ | 0.43 |
| Soy Plus | 1.52 | 1.29 | 2.55 | 2.23 | 0.48 | 0.40 | 0.43 |
| **TMRs** | | | | | | | |
| 20% Concentrate | 22.4$^{bc}$ | 27.1$^{a}$ | 24.0$^{b}$ | 28.2$^{a}$ | 17.4$^{d}$ | 20.6$^{c}$ | 0.54 |
| 40% Concentrate | 18.0$^{c}$ | 20.8$^{b}$ | 18.8$^{c}$ | 22.0$^{ab}$ | 12.6$^{d}$ | 15.8$^{c}$ | 0.54 |
| 60% Concentrate | 13.8$^{b}$ | 15.9$^{a}$ | 16.1$^{a}$ | 16.8$^{a}$ | 9.51$^{c}$ | 11.8$^{bc}$ | 0.54 |
| 80% Concentrate | 9.45$^{b}$ | 8.60$^{b}$ | 11.6$^{a}$ | 10.3$^{a}$ | 6.77$^{bc}$ | 8.16$^{b}$ | 0.54 |
| **Fecal sample** | | | | | | | |
| High starch | 23.0$^{ab}$ | - | 25.1$^{a}$ | - | 17.4$^{c}$ | - | 0.53 |
| Low starch | 26.8$^{a}$ | - | 25.8$^{a}$ | - | 18.5$^{b}$ | - | 0.53 |

$^{a,b,c,d}$ Least squares means within the same row with different superscripts
Bag size: S= 15 µm; M = 25 µm; L = 50 µm;
Particle size: S = 1 mm; L = 2 mm

## Summaries

- BS15PS2 is the recommended methodology to determine iNDF concentration based on other studies
- Bag pore size affected iNDF concentration of all the tested samples, while sample particle size only affected iNDF of forage and TMR samples
- BS50 with either PS1 or PS2 resulted in the lowest iNDF concentration for all tested samples
- Concentration of iNDF for CS with BS25PS1 was not different from BS15PS2
- Concentration of iNDF for AS and TMRs with 20%, 40% and 60% concentrate was not different between BS25PS2 and BS15PS2
- For high NDF forage, e.g. GH and WS, BS25 with either PS1 or PS2 can replace BS15PS2

## CONCLUSIONS

- BS50 (in situ bags) is not recommended for iNDF determination
- BS25PS2 (F57 bags with 2 mm sample particle size) could be used to determine iNDF for corn silage, alfalfa silage, high fiber forage, and TMRs with low to medium concentrate
- Fecal sample (1 mm) could be determined by BS25 (F57 bag)

## References


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