



Passage of liquid and fiber particles in dairy cows fed diets differing in NDF from conventional and bmr corn silages

Abstract
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K. W. Cotanch¹, C. Kokko¹, H. M. Dann¹, J. W. Darrah¹, R. J. Grant¹ and D. R. Mertens²
¹ William H. Miner Agricultural Research Institute, Chazy, NY
² Mertens Innovation & Research LLC, Belleville, WI



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INTRODUCTION

- Nutrient digestibility is a function of rate of digestion and passage
- Ration NDF content is known to limit DMI of high producing dairy cows by contributing to gut fill
- Higher quality forage with improved NDF digestibility (NDFD) affects rates of digestion and passage, DMI, and milk yield
- Current Ration Models typically:
 - have a single pool NDF
 - use linear kinetics of digestion (kd) and passage (kp)
 - do not use particle size to adjust digestion and passage
 - do not account for passage from rumen of various sized particles or sequential reduction of particle size from large → medium → small
- Understanding how the amount and digestibility of NDF affect particle size reduction and passage rate will allow improved estimates of DMI, digestion, passage, microbial yield, rumen health and milk production

OBJECTIVE

To determine the effect of level and digestibility of NDF from CS or BMR on rumen retention time of large, medium, small and indigestible forage particles and liquid

MATERIALS & METHODS

Experimental Design

- 4 x 4 Latin square (21-d periods)
- 8 ruminally cannulated, multiparous lactating Holstein cows (88 DIM, 685 kg BW)

Diets

- 2 levels of forage – High (H) and Low (L)
- 2 sources of CS - Conventional (CCS) and BMR (BMR)
- Within forage level, diets were balanced on NDF basis with similar %NDF from CS
 - LCCS – Low forage conventional corn silage
 - HCCS – High forage conventional corn silage
 - LBMR – Low forage BMR corn silage
 - HBMR – High forage BMR corn silage

Table 1. Characterization of forages

Forage	DM	NDF	ADL	Starch	NDFD ₂₄
CCS	37.1	36.6	3.0	36.0	39.0
BMR	36.4	38.3	2.4	34.5	50.8
HCS	36.5	48.1	5.1	1.3	56.5

Table 2. Formulated rations

	LCCS	HCCS	LBMR	HBMR
TMR NDF, %DM	29.1	33.7	30.0	34.5
NDF from CS, %DM	14.8	20.7	14.6	20.4
% NDF from CS	50.8	61.6	48.7	58.9

Forage particle preparation and marking

- 5 particle sizes of NDF were prepared and marked with different rare earth (RE) elements
- Fecal NDF particles were used to determine passage of the rapidly escaping fine fiber pool
- Hay crop silage (HCS) grass particles were used to determine effect of treatment on flow/passage of uniform digestible particles across treatments
- CS and BMR was dried and floated in water to remove starch
- All particles (Feces, HCS, CCS, and BMR) were soaked 24 h in NDS, rinsed with water, dried at 55°C and vertically sieved (RoTAP) to obtain size fractions

Table 3. Characteristics of marked particles

Particle	Size, mm	Marker	Dose Amount, g
Liquid	--	Co-EDTA	20
Fine fecal	< 2.36	Cr	45
Medium HCS	1.18 – 4.75	La	280
Small CCS/BMR	0.30 – 1.18	Sm	25 / 60
Medium CCS/BMR	1.18 – 4.75	Yb	310
Large CCS/BMR	> 4.75	Pr	310

Determination of passage rate

- Marked particles were ruminally dosed on d 14 before feeding
- Fecal samples were collected at 0, 3, 6, 9, 12, 18, 24, 30, 36, 42, 48, 60, 72, 84, 96, 120, 144, 168 h post dosing
- Feces dried 55°C for 48 – 72 h, ground UDY 2 mm, microwave digest, ICP
- Mean retention time (MRT) was calculated from area under marker excretion curves

Table 4. Treatment diet analysis

Diet	LCCS	HCCS	LBMR	HBMR
%Forage	52.7	68.4	49.4	63.5
CCS	39.3	55.0	--	--
BMR	--	--	36.1	50.2
HCS	13.4	13.4	13.3	13.3
CM	17.3	1.6	20.4	6.3
Grain Mix	30.1	30.1	30.1	30.1
Analyzed Nutrient Composition				
DM	52.2	45.8	52.8	47.0
CP	17.0	17.0	16.7	16.7
NDF	32.1	35.6	31.5	35.1
Starch	28.0	21.2	27.8	23.8
Fat	4.0	3.9	4.4	4.5
NDFD ₂₄	56.3	54.0	62.0	60.3
peNDF	17.3	23.1	18.5	21.5

RESULTS

Table 5. Mean retention time

Mean retention time, h	LCCS	HCCS	LBMR	HBMR	SE
Liquid	20.5	20.9	20.7	19.4	0.6
Fine fecal	29.5	30.7	31.2	32.2	0.8
Medium HCS particles	41.8	43.3	42.7	41.9	1.6
Small CCS/BMR particles	36.1 ^y	39.8 ^x	37.5 ^{xy}	36.5 ^{xy}	1.3
Medium CCS/BMR particles	44.9 ^{xyz}	46.0 ^{bx}	43.7 ^{abyz}	42.1 ^{bz}	1.5
Large CCS/BMR particles	47.5	48.8	47.9	46.8	1.6

^{xy} P ≤ 0.05, ^{xyz} P ≤ 0.10

SUMMARY

- MRT of liquid, fecal, medium HCS and large CS particles were unaffected by treatment
- MRT of small CS particles differed by percent forage in the ration
 - May be an artifact of small dosing amount
 - Yield of small CS particles was very small compared to yield of BMR particles
- MRT of medium BMR particles tends to be less than medium CS particles
 - Tendency for smaller MRT of BMR fiber suggests that it has different particle characteristics or greater fragility than CS
- Forage level did not affect MRT of particles within CS type

IMPLICATIONS

- NDFD had greater effect on MRT of particles than did percent forage of diet
- Higher NDFD forage tends to have lower rumen residence time
- NDFD of feed particles needs to be considered when modeling particle size reduction, digestion and passage

MRT of liquid and particles averaged by treatment across all cows

