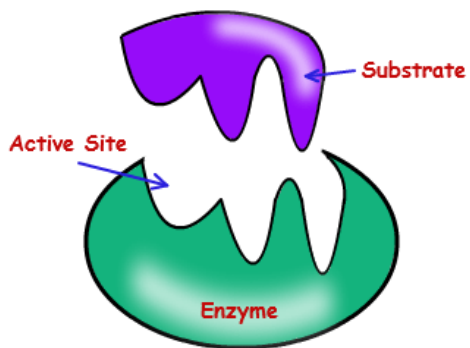


THE EFFECT OF FIBROLYTIC ENZYMES ON LACTATION PERFORMANCE, FEEDING BEHAVIOR, AND DIGESTIBILITY OF HIGH PRODUCING DAIRY COWS FED BARLEY SILAGE BASED DIET

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Ministry of Agriculture Strategic Feed Research Chair
Program:
Feeds Research & Development

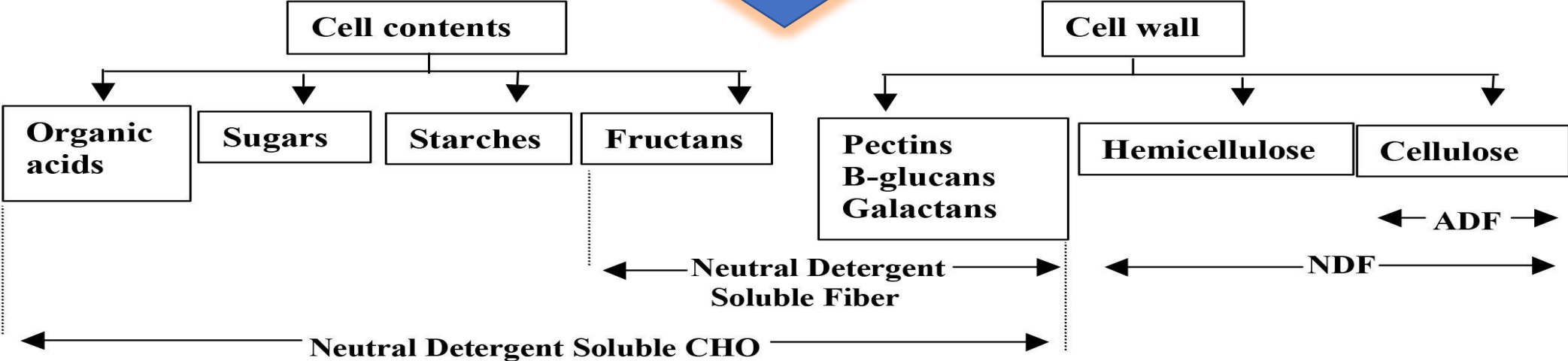
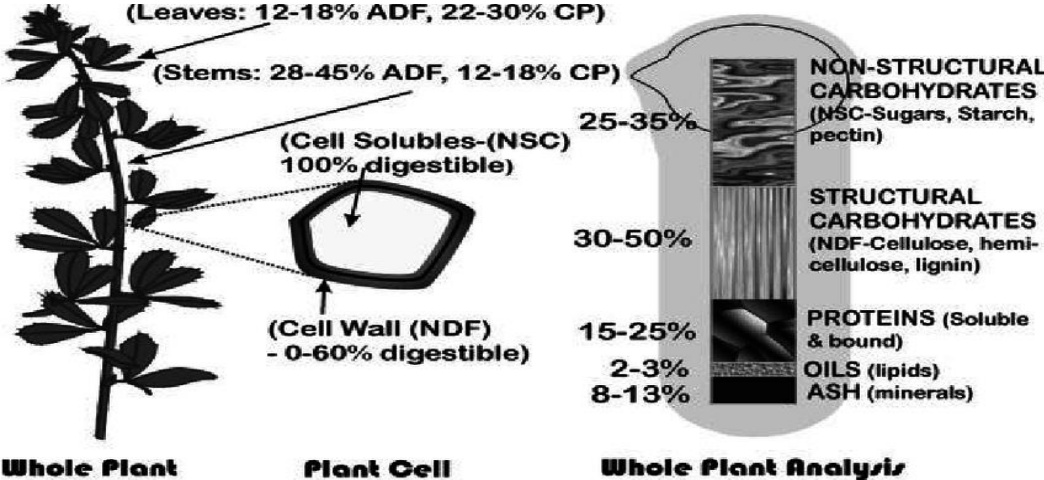


Feed Research Funding Support

- ❑ Sask. Ministry of Agriculture Strategic Research Chair (Dr. Yu): **Feed Research & Development**
- ❑ ADF fund
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- ❑ SaskMilk
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INTRODUCTION

Plant Carbohydrates



Creating new Nutritional and Economic Value from Fibre

- Fibre is a key component of the ruminant diet and subsequently has a notable impact on performance
- Digestibility of fibre can markedly affect performance through its influence on the availability of energy and protein
- The ruminal digestibility of NDF is rarely greater than 50%, less when rumen conditions are not favorable for adequate fibrolytic activity, as occurs with high grain diets

Beauchemin et al., 2001
Van Soest, 1994

Importance of Improving the forage Fiber Digestibility

1 unit increase in NDF dig =
+0.17 kg/d DMI
+0.25 kg/d 4% FCM

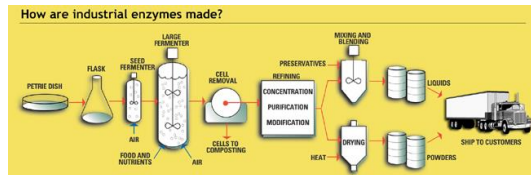
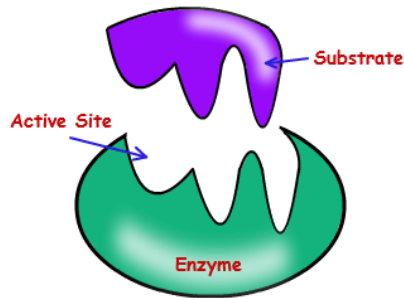
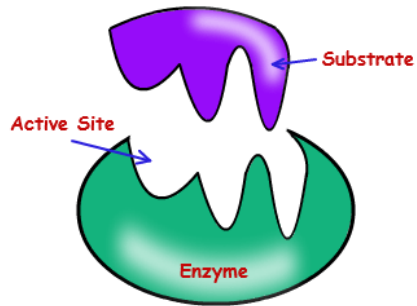
(Oba and Allen 1999)

Improving the Forage Fiber Digestibility

- **Significant improvement in forage cell wall digestibility have occurred through:**
 - **Forage breeding programs**
 - **Agronomic advances (adjust the cutting height of forage, harvest at the optimal stage of maturity)**
- **Despite these improvements, forage digestibility still limits the intake of available energy by high producing dairy cows during lactation, particularly early lactation.**

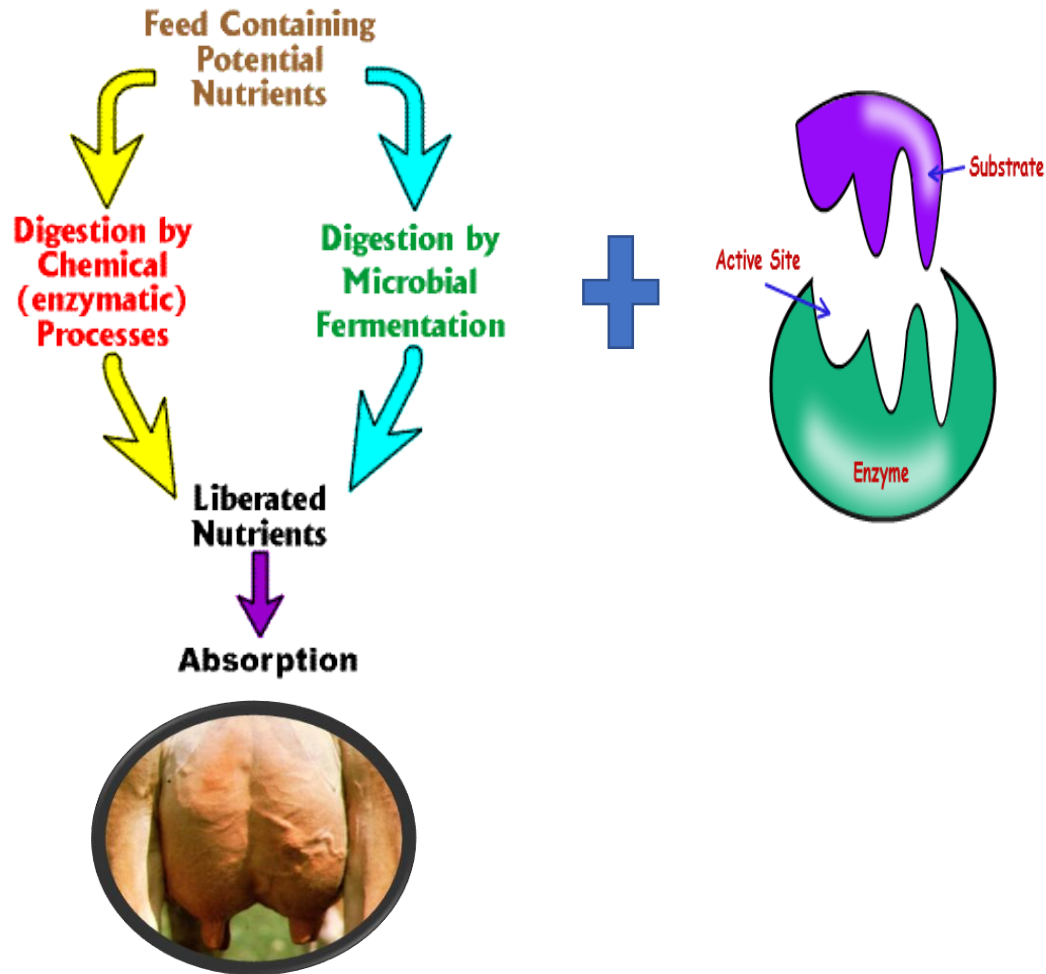


Ruminant Feed Enzymes



- Products of microbial fermentation
 - fungal (*Trichoderma*) and bacterial origin
- “Non-viable”, source organisms removed
- Concentrated enzymic activities
 - polysaccharidases (cellulases and xylanases)

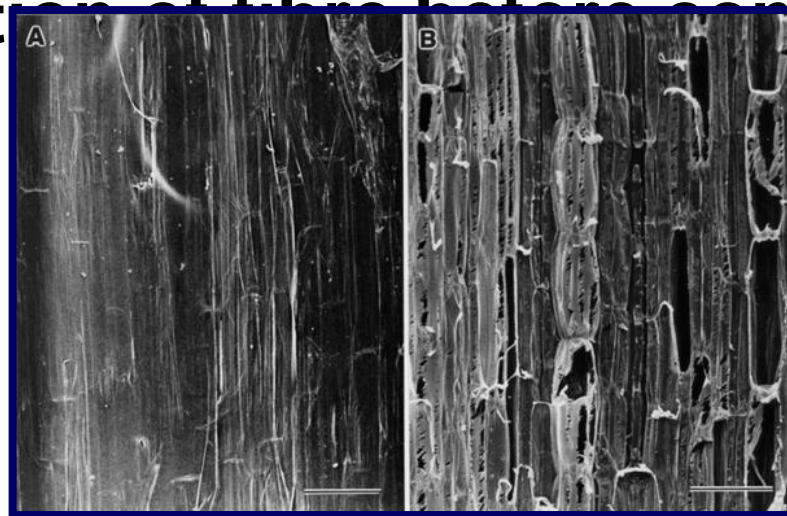
Ruminant Feed Enzymes (Mode of Action)



- When Enzymes product are fed to dairy cows diets, the main site of action is the rumen.
- Enzymes assist the rumen microbial population by preforming some of these digestion
- Improve fibre utilization, resulting in greater energy release from roughages and fibrous co-products that can deliver improved efficiency and performance.

Ruminant Feed Enzymes (Mode of Action)

- When applied directly onto the Total Mixed Ration as a liquid, ENZ starts to work immediately to break down forage surface fibre.
- Enables pre-digestion of fibre before consumption.



control

enzyme

Understanding the Variability in Response

- **Enzyme selection (activity and level)**
- **Forage quality**
- **Method of providing the enzyme to the animal**

The Cost of Exogenous Enzymes

- An important aspect of the use of exogenous enzymes in ruminant feeding is the potential to reduce the grain level in the ration reducing costs.
- Some evaluations in the dairy cattle (for 114 days) show an increase in production of 1.5 kg/d, but the cost of the enzymes was US\$0.39/dose/cow, leaving a profit of US\$ 0.09/cow/day.
- Economic losses could be substantial if the investment in enzymes is not matched by increases in production because lower forage quality limits the effect of the enzyme



 **objectives**

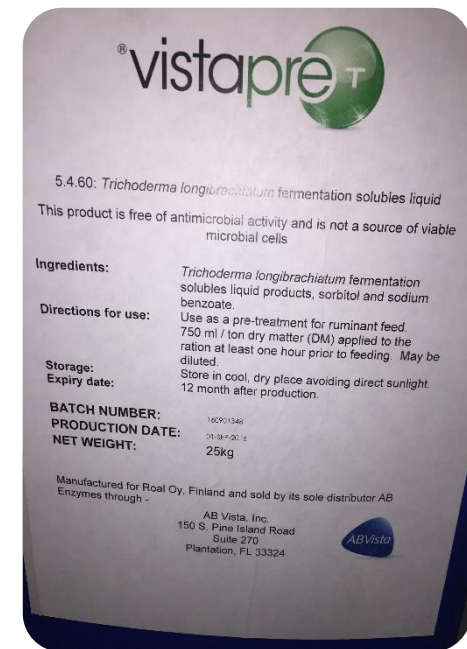
Objectives

- This study aimed to evaluate the effects of supplementing of new fibrolytic enzyme product applied directly to barley silage- based diet fed to dairy cows during mid-lactation on
 - Milk yield
 - Milk composition
 - Nutrient intake and digestibility
 - Predicted energy
 - Feeding behavior

Two-part study:

Part I. In vitro study: conducted to see whether or not this product would have a positive response before proceeding to animal experiments

- **Doses:** 0 (Control), 0.25, 0.5, 0.75, 1, and 1.25 ml of FE /kg DM of silage
- **Enzymes source:** *Trichoderma reesei*-derived fungal extract
- **Enzymes activity:** mixture of xylanase and cellulase



Part II. Lactation study

- The dairy trial was performed using eight Holstein dairy cows
- The cows were fed a TMR consisting of (on a DM basis)
 - 34.0% barley silage, 16.0% alfalfa hay, 19.7% barley grain, 30.0% concentrate
- The experimental treatments consisted:
 - (Basal TMR control, and the basal TMR supplemented with +
3 levels of a commercial fibrolytic enzyme
(0.50, 0.75, and 1.0 mL of enzyme/kg DM of TMR))

Part II. Lactation study

- ❑ The enzyme mixture was prepared twice a week.
- ❑ The enzyme liquid was sprayed onto the TMR
- ❑ The TMR was kept for approximately 1 h to increase enzyme efficacy.



Part II. Lactation study

Measured parameters

- Milk yield and composition
- Feed efficiency
- Feeding behavior(eating time, meal size and meal frequency): Insentec feeders
- Nutrients digestibility



Results



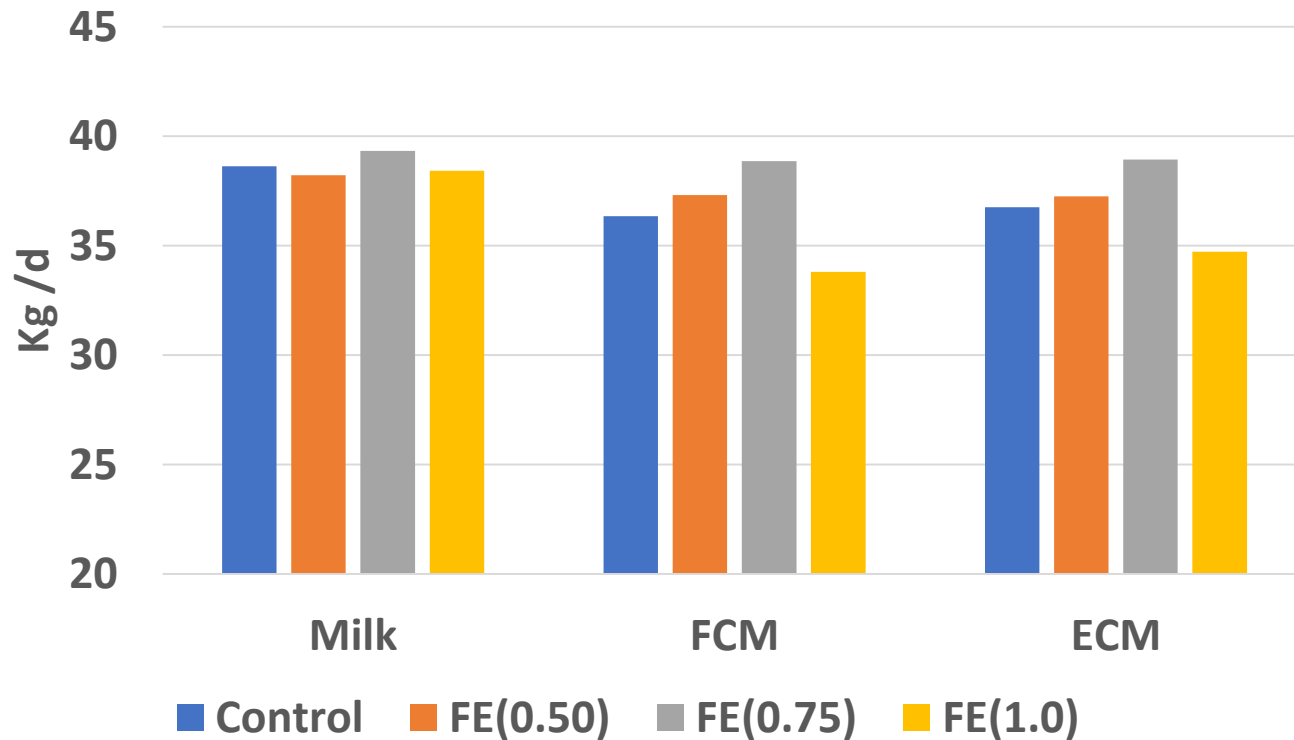
Part I. In vitro study: results

- **The results showed that enzyme level had significant effect on in vitro DM digestibility.**
- **Based on these findings, three levels of FE were selected (0.5, 0.75, and 1.0 ml/ kg DM diet) to assess the effects of enzymes on nutrients digestibility of barley silage-based diet and lactation performance in dairy cows.**

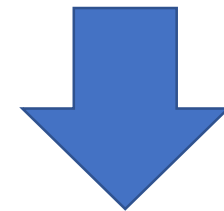
Effect of Fibrolytic Enzymes on Feed Intake and Total-Tract Nutrient Digestibility

	Enzyme levels (ml enzyme / kg TMR)				SEM	Polynomial contrast		
	Control	0.50	0.75	1.00		Linear	Quadratic	Cubic
Intake, kg/d								
DM	27.26	27.34	27.64	27.24	0.442	NS	NS	NS
OM	25.46	25.56	25.84	25.42	0.412	NS	NS	NS
NDF	8.31	8.35	8.46	8.27	0.131	NS	NS	NS
pdNDF	4.55	4.62	4.74	4.56	0.074	NS	0.07	0.07
Digestibility, %								
DM	68.42	66.09	70.83	69.05	1.07	NS	NS	NS
OM	66.42	65	68.51	67	0.924	NS	NS	0.02
NDF	47.3	44.17	53.44	49.72	1.947	NS	NS	0.01
pdNDF	79.59	72.94	88.64	83.08	3.946	NS	NS	0.02

Effect of Fibrolytic Enzymes on Milk Production



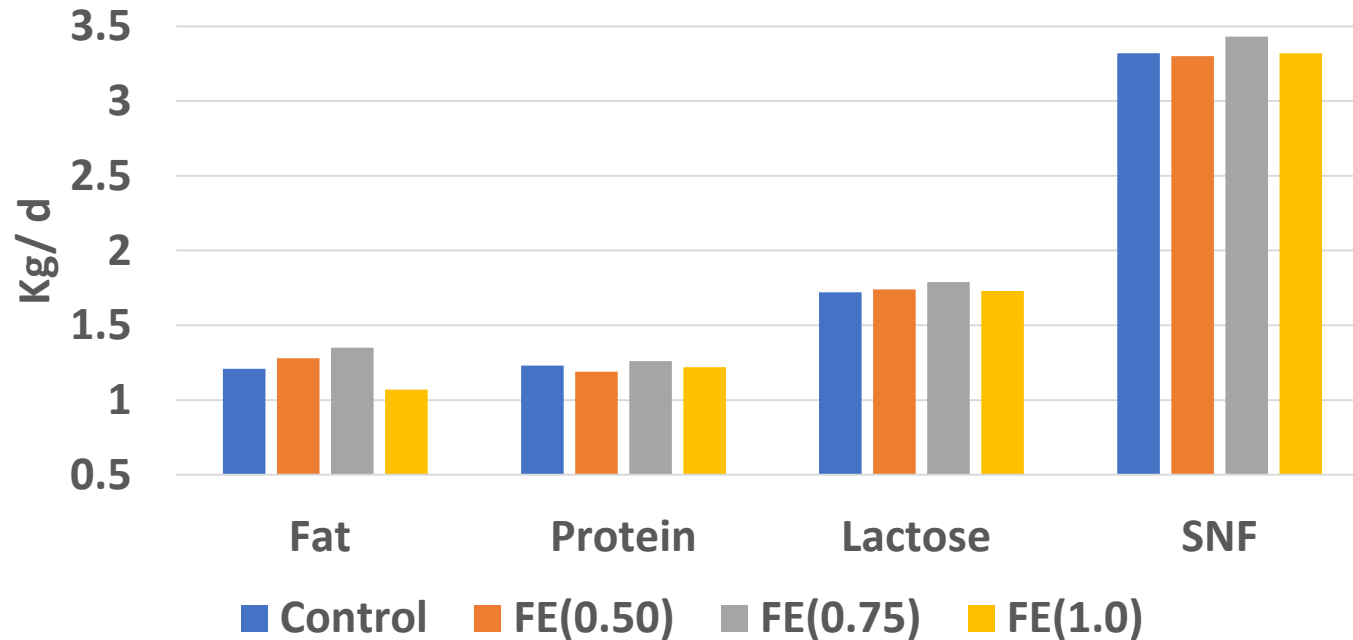
The intermediate dosage level (**0.75 ml/kg DM TMR**) exhibited the best effect on Milk yield,



Due to improving the total tract NDF digestibility, hence increase the available energy content in the diet

Items	Polynomial contrast values		
	Linear	Quadratic	Cubic
Milk, Kg/d	NS	NS	0.036
FCM, Kg/d	NS	0.01	0.056
ECM, Kg/d	NS	0.02	0.028

Effect of Fibrolytic Enzymes on Milk Component Yield (kg/cow/d)



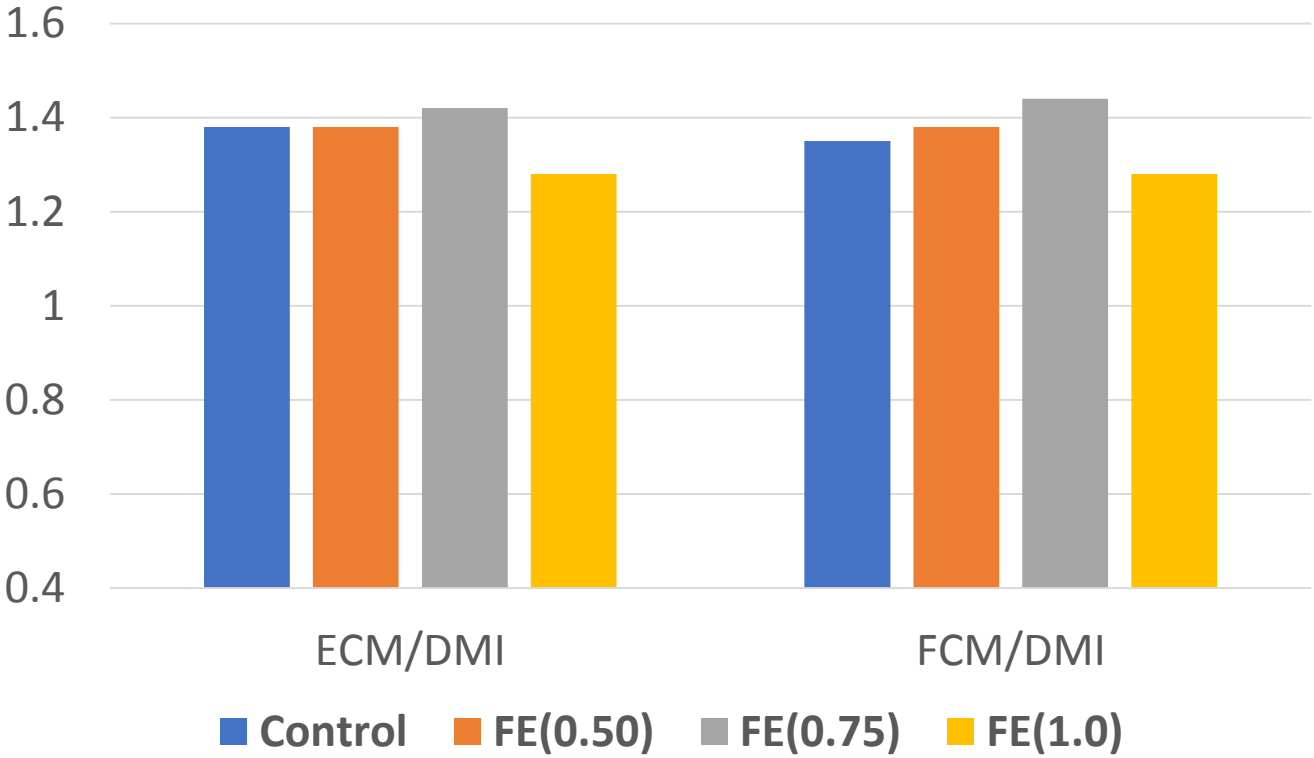
The intermediate dosage level (**0.75 ml/kg DM TMR**) exhibited the best effect on Milk component yield



Increase in the **fermentable carbohydrates** amount in the rumen as a consequence of enzyme supplementation

Items	Polynomial contrast values		
	Linear	Quadratic	Cubic
Fat, Kg/d	NS	0.02	NS
Protein, Kg/d	NS	NS	0.03
Lactose, Kg/d	NS	NS	0.04
SNF, Kg/d	NS	NS	0.02

Effect of Fibrolytic Enzymes on Feed Efficiency



The diet supplemented with 0.75 mL/kg of TMR exhibited the highest feed efficiency compared to the other doses

Items	Polynomial contrast values		
	Linear	Quadratic	Cubic
ECM/DMI	NS	0.07	NS
FCM/DMI	NS	0.07	NS

Effect of Fibrolytic Enzymes on Feeding Behavior

Item	Enzyme levels (ml enzyme / kg TMR)				SEM	Polynomial contrast values		
	Control	0.5	0.75	1.00		Linear	Quadratic	Cubic
Meal bouts, d	9.1	8.4	8.7	9	0.39	0.73	0.21	0.76
Eating time, min/d	225.5	233.3	225.6	232.8	9.09	0.43	0.85	0.22
Meal length, min	26.3	28.8	27.3	27.2	1.95	0.73	0.37	0.54
Eating rate, g/min	124.6	122.3	125.1	124.9	4.84	0.87	0.61	0.62
Meal size, kg								
DM	3.2	3.5	3.4	3.3	0.18	0.63	0.29	0.66
OM	3	3.3	3.1	3.1	0.17	0.64	0.30	0.66
NDF	1	1.1	1	1	0.06	0.62	0.29	0.72
pdNDF	0.5	0.6	0.6	0.6	0.03	0.58	0.23	0.81

- There was no effect of enzyme level on feeding behavior.
- The lacking effect is attributed to the limited effect of enzymes on feed intake.

Total Revenue of Milk yield

Items	Control	Enz (0.75 ml/kg DM TMR)
<i>Milk composition</i>		
Butter Fat %	3.12	3.28
CP %	3.21	3.22
OS %	5.25	5.33
BF (kg/cow/d)	1.18	1.28
CP (kg/cow/d)	1.23	1.26
OS (kg/cow/d)	2.03	2.11
<i>Cost of milk components</i>		
BF (\$) - November 2017	10.93	10.93
CP (\$) - November 2017	7.93	7.93
OS (\$) - November 2017	1.19	1.19
<i>Revenue (Considering the cost of enzymes)</i>		
Revenue BF (\$)	12.88	14.03
Revenue CP (\$)	9.73	9.96
Revenue OS (\$)	2.41	2.50
Total revenue \$ (Cow/day)	25.01	26.50

Take Home Message

- **Based on the current study, the optimum dosage of the fibrolytic enzymes was 0.75 mL enzyme/DM kg of TMR.**
 - **Applying this dosage improved NDF digestibility, and FCM yield**
 - **The feed efficiency increased by up to 7% without any increase in DMI compared to the control diet**
- **Enzyme can increase NDF digestion**
 - **By increasing NDF digestion we can increase energy content of the diet**
 - **Allowing more forage (%) to be fed**

Acknowledgment

- **Supervisor: Dr. Peiqiang Yu**

- **Committee Members:**
 - **Dr. David Christensen**
 - **Dr. John McKinnon**
 - **Dr. Wenzhu Yang (AAFC Scientist)**
 - **Dr. Aaron Beattie**
 - **Dr. Tim Mutsvangwa (chair)**

Thank
— you



Statistical Analysis

- ❑ The data were analyzed using Proc Mixed SAS with a model: $Y = \mu + \text{Trt} + \text{Cow} + \text{Square} + \text{Period} + \text{error}$
- ❑ The final variance and covariance structure model were selected based on AIC and BIC values
- ❑ Polynomial contrasts were used to determine the effect (linear and quadratic) of increasing the amount of enzyme application.
- ❑ Significance was declared at $P \leq 0.05$ and a trend at $0.05 < P < 0.10$ unless otherwise stated
- ❑ The accumulated gas production and in vitro DM and NDF digestibility data were analyzed as **RCBD**