Use of Glycerol, High Oil Canola Meal and DDGS for Lactating and Transition Cows

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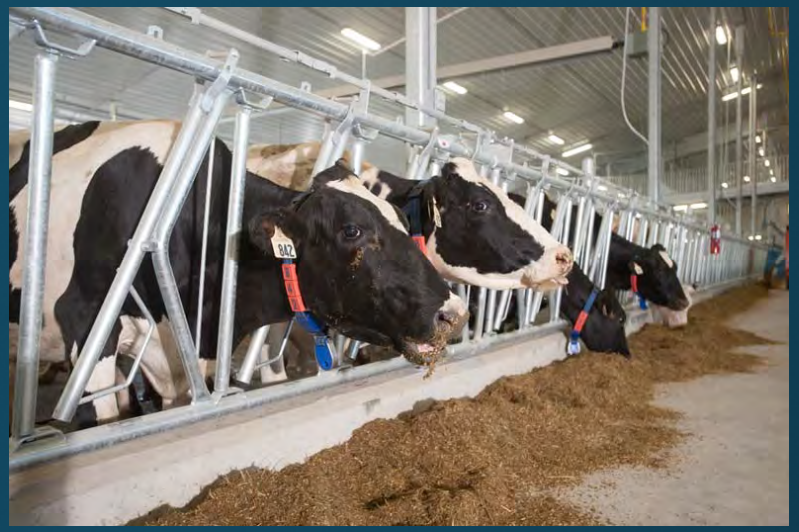
Canola Meal for Dairy Cattle: Background



- Canola meal (CM) is very suitable as a protein supplement for dairy cows
- Many studies have shown that CM increases milk production by 1 kg/day
- Superior amino acid profile; protein solubility and bypass in rumen
- Canola meal export to USA: 1 million T/year
- California is the main market
- Market expansion opportunities in eastern US

New Dairy Feed Products from Canola - Glycerol

- **Glycerol** is a feed by-product from the biodiesel industry – glycerol moiety of the triglyceride
- Glycerol ~ 10% by weight of the canola oil
- Unique glucogenic, high energy source
- Variable quality with concern for methanol residue
- CFIA does not allow registration under Schedule IV Approved Feed Ingredients
- We are developing research data for application to CFIA for dairy use
- Field study targeted for 2015

Glycerol Quality Grades[1]

Variable/Purity	Low	Medium	High
Water %	25 - 28	10-12	2.0 – 3.0
Glycerol (% of DM)	60 - 65	85 - 90	98 – 99
Ether Extract %	0.8 - 6	0.4 – 0.7	?
Phosphorus %	0.9 – 1.5	2.0 – 2.5	?
Sodium %	0.11	0.09	?
Methanol %	24 - 27	0.04 – 1.0	-----

[1] Schroder, A. and K. Sudekum, University of Kiel, Germany. Glycerol By-product of Bio Diesel Production for Ruminants.

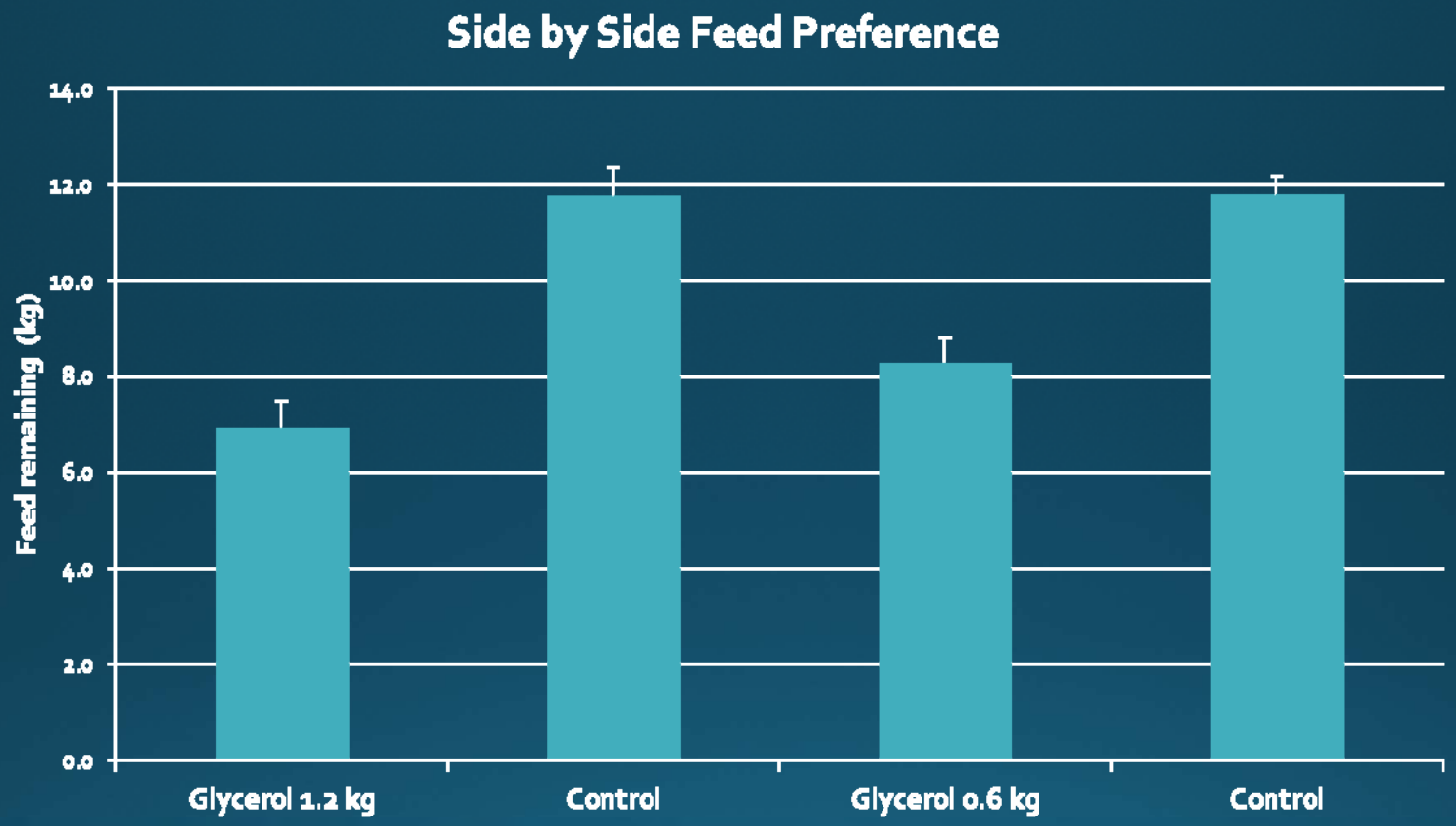
Regulatory – it is about methanol

- US FDA: allows ≤ 0.15% methanol in glycerol and up to 10% glycerol for monogastric diets and 15% for ruminant diets
- EU Expert Committee recommendation: < 0.5% methanol and up to 10% glycerol in ruminant diets
- Canada CFIA: under consideration. Temporary permit ≤ 0.15% methanol and up to 5% of DM in beef diets

New Dairy Feed Products from Canola - High Oil Canola Meal (HOCM)

- Distressed canola seed - cold press extrusion typical of small biodiesel plants (Milligan)
- About 10-12% residual canola oil and 82-84% TDN
- Increased energy intake due to high fat content
- PUFA could be used to modify milk fat composition including Conjugated Linoleic Acid (CLA) content

Effect of glycerol on feed preference



Feed remaining in feed tub after 40 min (kg/cow/day). Five day average; n=8. Lower value indicates higher preference. Cows showed high feed preference for glycerol.

Research Projects (4)

We have performed four (4) research projects with glycerol, and glycerol, HOCM and DDGS combinations using 72 cows from 2012-2014

Funded by:

- SaskMilk
- ADF - Agriculture Development Fund Saskatchewan
- CAAP – Canadian Agricultural Adaptation Program through the Agriculture Council of Saskatchewan
- North West Terminal
- Milligan Biotech Inc.

Research Projects at old dairy barn

- **Project I**. A 4-month lactation trial (n=8) with glycerol at 0, 0.6, 1.2 and 2.4 kg glycerol per day. 0.6 kg glycerol at 5% of concentrate was provided in pellets only (max). For 1.2 and 2.4 kg glycerol treatments, an additional 0.6 kg or 1.8 kg were mixed into the TMR by top dress
- **Project II**. An 8-week (-2w to +6w) transition trial (n=24). Feed treatments (3): control TMR; TMR +1 kg glycerol; TMR + 1 kg glycerol + 1 kg HOCM -1 kg CM). All treatments top dress
- TMR was formulated for 42 kg milk with 3.75% milk fat and 3.25% milk protein, and to allow growth of 0.26 kg/d.

Research Projects at Rayner Centre

- **Project III.** A 4-month lactation trial (n=8). Treatments (4) were TMR; TMR + 1 kg glycerol; TMR + 1 kg glycerol and 1 kg HOCM; TMR + 1 kg DDGS. All by top dress. Formulated for body weight of 680 kg, at 120 DIM, 42 kg milk/day with 3.88% fat and 3.36% protein, with growth of 0.011 kg/day
- **Project IV**. An 8-week (-2w to +6w) transition trial (n=32). Treatments (2) were control TMR and TMR +1 kg glycerol + 1 kg HOCM + 1 kg DDGS. All treatments top dress.

Effect of glycerol level on dry matter intake, weight gain, yield and milk composition of lactating dairy cows[1]

Project I

	Glycerol					P value Trt	Polynomial contrast P value		
Items	**0 kg**	**0.6 kg**	**1.2 kg**	**2.4 kg**	**SEM[1]**		**Linear**	**Quadratic**	**Cubic**
Dry matter intake (kg/d)	26.16	26.88	26.63	26.75	0.284	0.335	0.299	0.314	0.250
Weight gain (g/cow/d)	-32	310	166	408	163.5	0.292	0.127	0.719	0.265
Yield (kg/d)									
Total Milk	43.56	45.92	46.06	46.86	1.339	0.372	0.135	0.449	0.617
FCM	39.21	42.25	40.18	40.7	1.758	0.674	0.803	0.576	0.296
ECM[2]	40.05	41.9	42.34	42.65	1.48	0.614	0.269	0.500	0.817
Protein	1.39	1.46	1.47	1.52	0.039	0.170	0.039	0.512	0.648
Fat	1.26	1.3	1.32	1.3	0.069	0.912	0.662	0.578	0.974
Lactose	2.01	2.12	2.14	2.2	0.064	0.259	0.070	0.518	0.640
Solids-not-fat	3.82	4.05	4.07	4.18	0.078	0.062	0.038	0.720	0.070
DMI : FCM yield	0.69	0.64	0.69	0.66	0.03	0.589	0.715	0.707	0.212

[1] SEM = standard error of mean.

[2] ECM = Energy corrected milk.

Effect of glycerol level on dry matter intake, weight gain, yield and milk composition of lactating dairy cows[1]

Project I

	Glycerol					P value Trt	Polynomial contrast P value		
Items	**0 kg**	**0.6 kg**	**1.2 kg**	**2.4 kg**	**SEM[1]**		**Linear**	**Quadratic**	**Cubic**
Fat (%)	2.88	2.89	2.87	2.82	0.107	0.973	0.678	0.844	0.964
Protein (%)	3.18	3.2	3.2	3.24	0.035	0.723	0.279	0.926	0.797
Lactose (%)	4.61	4.63	4.64	4.7	0.022	0.067	0.010	0.779	0.929
Solids-not-fat (%)	8.77	8.81	8.83	8.91	0.036	0.074	0.011	0.794	0.763
Total solids (%)	11.57	11.63	11.63	11.69	0.083	0.782	0.332	0.934	0.796
MUN[2] (mg/dL)	16.5	13.7	15.2	12.8	0.86	0.034	0.020	0.752	0.056
SCC[3] (10^3 cells /ml)	24	40	30	28	6.8	0.432	0.968	0.297	0.206

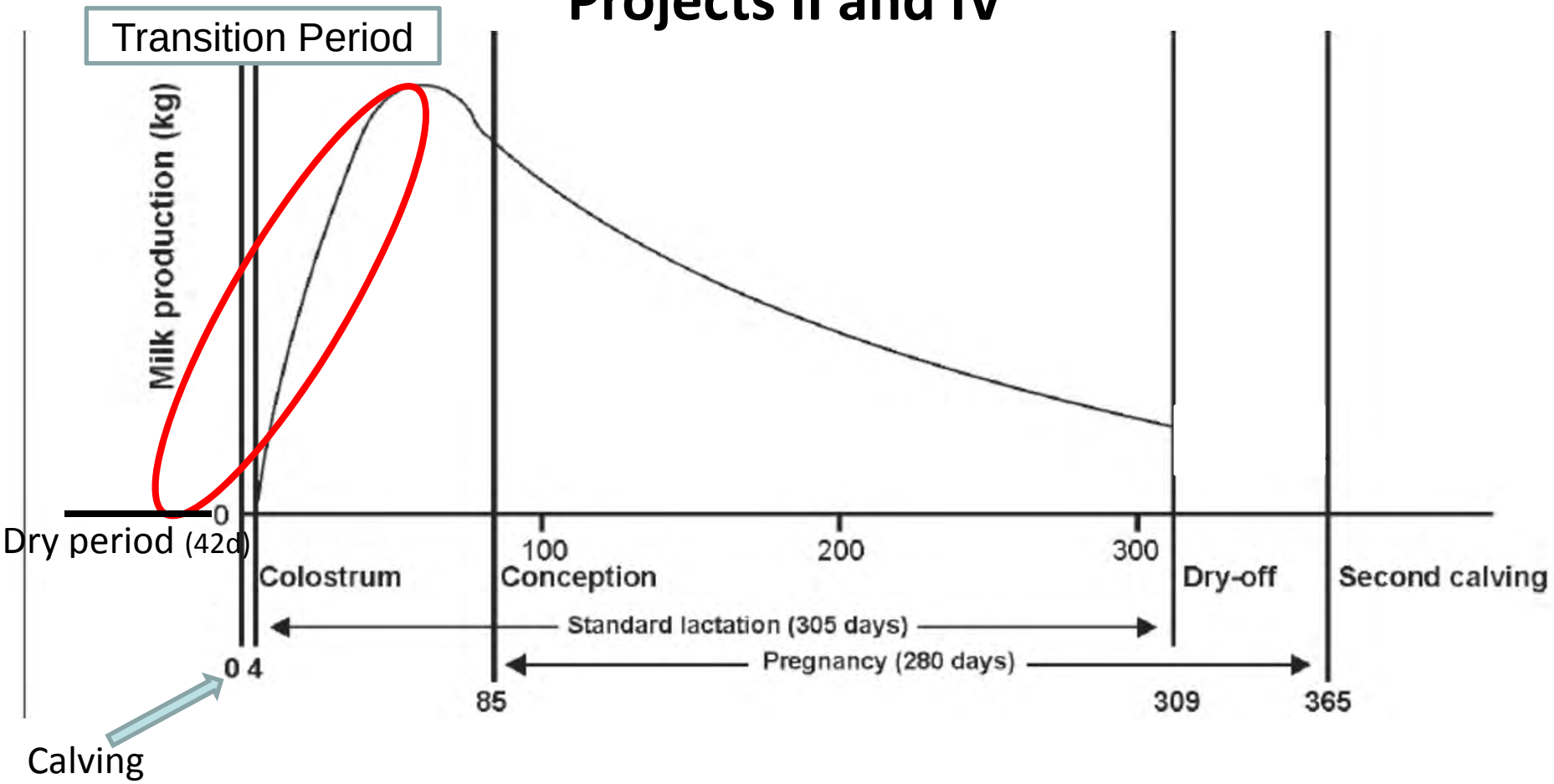
[1] SEM = standard error of mean.

[2] MUN = Milk urea nitrogen.

[3] SCC = Somatic cell count.

High Metabolic Demand in Early Lactation

Projects II and IV



Transition Period: High energy requirement and rapid adaptation of metabolism to sudden high milk production.

Cows have difficulty increasing feed intake and lose weight to provide energy for milk production → metabolic stress and disease limit production and lower fertility.

Observations Transition Trial Project II

- **Three of eight** cows on the control diet required glycol treatment between days 7 and 14 pp
- **One of eight** cows fed the TMR + glycerol diet required glycol treatment between days 7 and 14 pp
- **No cows** fed the glycerol + HOCM diet required intervention
- Cows readily accepted the feeds

Performance of transition cows fed a Control or Treatment TMR - **Project IV**

	Post-Partum					
Item	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42
Dry matter feed intake kg/d						
Control	**18.93**	**21.90**	**23.69**	**25.93**	**26.60**	**27.71**
Control SE	0.91	0.89	1.10	0.96	1.02	1.13
Treatment	**20.63**	**23.38**	**26.14**	**26.91**	**27.88**	**29.08**
Treatment SE	0.71	0.89	0.88	0.91	1.07	1.07
Milk yield kg/d						
Control	**37.06**	**43.24**	**46.89**	**48.83**	**50.66**	**50.93**
Control SE	1.74	1.74	1.88	1.94	2.19	1.80
Treatment	**39.89**	**46.03**	**50.47**	**51.95**	**52.26**	**53.34**
Treatment SE	1.64	2.05	2.06	1.78	1.77	2.01
Milk fat %						
Control	**4.86**	**4.26**	**4.23**	**4.15**	**3.93**	**3.85**
Control SE	0.15	0.19	0.15	0.12	0.10	0.09
Treatment	**5.04**	**4.75**	**4.58**	**4.29**	**4.34**	**4.18**
Treatment SE	0.25	0.13	0.15	0.10	0.11	0.08

Lactation performance of transition cows fed a Control or Treatment TMR (2) **Project IV**

	Post-Partum					
Item	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42
4.0 % FCM kg/d						
Control	42.03	45.07	48.58	49.78	50.09	49.69
Control SE	2.39	2.46	2.38	2.01	2.31	1.80
Treatment	46.00	51.04	54.64	54.09	54.95	54.79
Treatment SE	2.23	2.22	2.17	1.82	2.10	2.11
ECM kg/d						
Control	44.15	47.42	50.59	51.75	52.25	51.93
Control SE	2.47	2.46	2.40	2.06	2.40	1.85
Treatment	48.57	53.36	56.78	56.33	57.08	56.97
Treatment SE	2.18	2.25	2.13	1.88	2.09	2.14
ECM kg/kg feed dry matter						
Control	2.38	2.17	2.15	2.00	1.97	1.89
Control SE	0.15	0.09	0.06	0.05	0.07	0.05
Treatment	2.39	2.30	2.18	2.10	2.06	1.96
Treatment SE	0.12	0.08	0.07	0.05	0.05	0.03

Performance of transition cows fed a Control or Treatment TMR (3) **Project IV**

	Post-Partum					
Item	Day 7	Day 14	Day 21	Day 28	Day 35	Day 42
Milk protein %						
Control	3.36	3.14	2.98	2.91	2.87	2.87
Control SE	0.08	0.06	0.06	0.05	0.05	0.05
Treatment	3.54	3.25	3.08	2.99	2.98	2.94
Treatment SE	0.07	0.07	0.06	0.07	0.05	0.05
Milk Urea Nitrogen mg/dL						
Control	11.52	11.59	11.33	11.77	12.46	12.45
Control SE	0.41	0.44	0.43	0.63	0.33	0.48
Treatment	9.77	11.42	11.45	11.57	11.52	11.80
Treatment SE	0.68	0.60	0.52	0.72	0.64	0.47
Body weight kg						
Control	683.60	663.71	666.75	671.56	668.50	670.00
Control SE	17.3	25.1	43.6	21.7	27.4	17.5
Treatment	691.73	685.14	705.38	705.55	693.36	696.27
Treatment SE	16.7	13.7	20.7	20.4	23.4	18.6

Glycerol and HOCM: complementary tools in the feeding tool box

- **Glycerol = rapidly available energy source**
- Provides soluble energy for improved rumen microbial protein synthesis
- Is a concentrated energy source for the cow (like corn)
- Taste enhancer - glycerol is sweet

- **HOCM provides canola oil and rumen by pass protein**
- Extra energy for the cow in a different form and improves energy balance
- Extra bypass protein for milk synthesis

- Glycerol + HOCM are well suited to boost nutrient supply in the transition cow

Glycerol

- Glycerol was tested up to 2.6 kg/d or 10% of DM of a barley grain/barley silage based TMR and was well tolerated:
  - No effect on DM intake and cows showed high preference for glycerol
  - Methanol was not detectable in milk.
- Glycerol energy feeding value is equal to that of corn.
- When including glycerol in the ration, ensure the ration contains adequate physically effective fiber.
- Glycerol can be used as a pelleting agent (but ≤5%) and to improve palatability of rations, stimulate feed intake, and in TMRs is very likely to prevent or reduce sorting of rations.
- Glycerol improves energy balance and lactation performance in lactating cows. Glycerol is a useful soluble energy source which can increase microbial protein synthesis resulting in better capture of rumen ammonia and lower milk MUN.

Glycerol and HOCM and DDGS

- The combination of glycerol with high oil canola meal appears to be more effective than glycerol alone in improving energy balance and lactation performance in lactating and transition cows
- High producing cows may not be able to meet nutrient requirements from their regularly formulated TMR with currently available feed sources:
  - Production responses occur when extra nutrients are provided by use of unique and synergistic feed supplements such as particularly the combination of glycerol and high oil canola meal.
  - The responses in these trials clearly indicate that feeding programs for lactating dairy cattle are dynamic, particularly when cows are nutritionally challenged such as during the transition period.

Next steps for 2015

- Work with CFIA to develop the file for approval of glycerol as a feed supplement in dairy cattle
  - Present data on 4 projects will be used as the foundation for licensing approval
  - Likely target 5-10 % of total diet DM (1-2 kg/day)
- Want to supplement data on glycerol with field research
  - Several producer farms
  - Testing of glycerol as a feed supplement in the TMR
  - Measure lactation performance and milk composition (DHI)
  - Feed and blood samples
  - Apply to the ADOPT program Agriculture Development Fund

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THANK YOU

Certificate of Analysis of Glycerol

Variable	
Water %	8.02
Glycerol %	85.01
Total fatty acids %	0.88
Ash %	7.42
Sodium chloride %	6.97
Methanol ppm	0.01

- Source of glycerol : Cargill Canada - Minnesota Soybean Processors, Brewster MN, USA