Evaluation of a rumen protected carbohydrate supplement prototype feed with fresh lactation dairy cows

Juan P. Russi [1], Paula F. Russi [1], Jose M. Simondi [2], Gaston M. Bonetto [2], Cecilia Naser Marzo [2], Julio A. Di Rienzo [3], Alejandro R. Castillo [4]

1 Rusitec SH. Argentina; 2 INTA EEA Manfredi Argentina; 3 National University of Cordoba, College of Agriculture, Argentina;
4 University of California, Cooperative Extension, Merced Co. CA

ADSA - Abstract #: W319 - New Orleans July 11-14, 2011

INTRODUCTION

Fresh cow energy metabolism could be characterized by a negative energy balance, high energy demand (largely glucose), intense lipid mobilization, insulin resistance, and frequently limited liver capacity to metabolize nutrients, mainly NEFA (Bauman, 2000; Grummer, 2010).

Drackley (1999), suggested that dietary fat does not suppress body lipid mobilization during early postpartum period, supplemental fat may further imbalance the mixture of fuels and lead to decrease DMI.

Postruminally starch utilization had little effect on milk energy output in early lactation non-fresh dairy cows (>28 DIM), increasing tissue energy retention and oxidative loss (Reynolds, 2004).

In fresh cows (<28 DIM), under limited liver metabolic capacity and insulin resistance, liver glucose precursors *via* rumen propionate should not be as efficient as glucose directly absorbed at the small intestine level. We hypothesize that is possible to reach the mammary gland increasing blood glucose supply through a rumen protected carbohydrate supplement.

OBJECTIVE

The objective was to feed a prototype rumen protected carbohydrate supplement to fresh lactation cows to determine if a patent pending manufacturing product is effective in protecting simple carbohydrates against ruminal degradation.

METHODS

Three studies were carried out at different INTA Experimental Stations in Argentina, as follow:

1. *In-vitro*-trial. This trial was planned to evaluate in-vitro degradability of 5 different prototypes of rumen protected carbohydrates. Degradability was estimated indirectly by measuring ammonia concentration in the batch cultures (Broderick and Kang, 1980). The two prototypes with least ammonia released were selected for a cockerels trial.

2. Cockerels trial. The objective was to estimate the True Metabolizable Energy (TME) of the two pre-selected rumen protected carbohydrate supplements from the *in-vitro* trial. Thirty-five adult Leghorn Cocks were used in a completely randomized 2x3 factorial design with 5 repetitions as described by Sibbald, 1976. The prototype with the highest TME was selected for a fresh cows trial.

3. Fresh cows trial. Twenty seven fresh lactation multiparous Holstein dairy cows were preselected according to previous lactation records and group fed the same basal diet from -21 days of expecting calving date to parturition. From calving to 28 DIM cows were assigned to three treatments in a randomized complete block design and fed a diet of (% DM): 31.4% corn silage, 19.4% alfalfa hay, 22.8% corn grain, 7.4% soybean seeds, 4% extruded soybean meal, 4.3% minerals & vitamins; and 10.7% basal supplement (58.9% solvent soybean meal, 41.1% soluble carbohydrate and urea). Treatments consisted on replacing 0% (T0), 50% (T1) and 100% (T2) of the basal supplement with the rumen protected carbohydrate prototype feed. The prototype feed had the same ingredients of the basal supplement. Cows were managed in two groups per treatment (6 groups in total) with 4-5 cows per group, respectively. DMI was daily measure by offer and refusal in each group of cows. Body weight (BW), BCS, and blood samples were taken once a week. Weekly samples of TMR were taken for feed analysis. Milk yield and milk composition per cow was measured two times per week on non-consecutive days. A weekly average of milk yield/cow/d, milk fat, protein, and lactose contents were used to estimate total net energy (NE) milk output (Mcal/cow/d).

Statistical Analysis: A mixed effects model was fitted to analyze experimental data. Fixed effects were: feed treatments, instances of evaluation (weeks) and a set of covariables: BW, milk yield & composition from previous lactations, 3-weeks pre-calving blood samples, and at calving BCS. The random effects were groups and cows within groups. Orthogonal contrasts were used to evaluate hypothesis of interest. Due to high variability in fresh cows, contrasts were considered significant with $P<0.10$.

RESULTS

In agreement to Grummer (2010), high variability was observed on some variables analyzed in this experiment. The post-partum DMI (1 to 28 DIM) were no different among treatments averaging 19.0, 20.2, and 21.1 Kg DM/cow/day SEM xxx) for T0, T1 and T2 respectively. The estimated mean diet nutrient composition was: 50% DM, 16.1% CP, 33.8% NDF, 6.1% fat, 7.5% ash. The results of milk yield, milk composition, blood ketone bodies and glucose, BCS, and BW changes are presented in Table 1.

Table 1. Effect of rumen protected carbohydrate supplement on fresh lactation dairy cows performance

	Treatments LSMeans					Orthogonal contrasts		
	T0	T1	T2			T0vs(T1+T2)/2	T0vsT1	T0vsT2
Items				SEM	*P*-values	*P*-values		
Milk NE[1], Mcal/cow/d	28.2	25.7	26.6	1.04	ns[2]	ns	ns	ns
Milk components								
Fat, %	4.08	4.06	4.15	0.17	ns	ns	ns	ns
Protein, %	3.36	3.47	3.48	0.07	ns	ns	ns	ns
Lactose, %	4.70	4.96	4.88	0.04	0.01	0.01	0.01	0.01
Total solids, %	12.8	13.2	13.3	0.20	ns	ns	ns	ns
Non fat solids, %	8.8	9.3	9.2	0.11	0.01	0.01	0.01	0.01
Urea, mg/dl	21.6	22.0	21.7	1.14	ns	ns	ns	ns
Blood								
Glucose, mg/dl	38.8	45.3	42.5	2.30	ns	0.07	0.05	ns
Ketone bodies, mg/dl	0.73	0.36	0.57	0.16	ns	ns	ns	ns
BCS, scale 1 to 5	2.96	3.00	2.95	0.06	ns	ns	ns	ns
BW change kg/cow/week								
Weeks 2 - 1	-5.4	-11.0	-13.3	6.39	ns	ns	ns	ns
Weeks 3 - 2	-20.5	-7.3	-5.7	6.33	ns	0.08	ns	0.09
Weeks 4 - 3	-5.0	-10.0	-3.9	5.40	ns	ns	ns	ns
Total 4 weeks	-37.1	-30.6	-27.3	10.85	ns	ns	ns	ns

1. NE = net energy ; 2. ns = non-significant

Lactose and non-fat solid contents in milk were 5% higher in (T1+T2)/2 when compared to T0. In terms of blood glucose content this difference was higher than 13% and consistent with body weight changes observed on the 2nd week of lactation, being the estimated mean of body weight changes in (T1+T2)/2 -6.5 kg/cow/week compared -20.5 kg/cow/week in T0, representing 3 times more BW loss in T0.

CONCLUSIONS

Based on milk lactose content, blood glucose, and body weight changes, it was concluded that the rumen protected carbohydrate supplement prototype was effectively protected against rumen microbial degradation.

REFERENCES

Bauman, D.E. 2000. Regulation of nutrient partitioning during lactation: Homeostasis and homeorhesis revisited. In: Ruminant Physiology. P.B. Cronje, ed. CABI Publ. Cambridge, MA. (quoted by Janovick et al., 2011)

Broderick, G. A., and J. H. Kang. 1980. Automated simultaneous determination of ammonia and total amino acids in ruminal fluid and in vitro media. J. Dairy Sci. 63:64-75.

Drackley, J.K. 1999. Biology of dairy cow during the transition period: the final frontier?. J. Dairy Sci. 82:2259-2273.

Grummer, R.R. 2010. Managing the transition cow-emphasis on ketosis and fatty liver syndrome. In: Proc. 31th Western Nutr. Conf. Sept. 21-23, Saskatoon, SK. Canada.

Janovick, N.A., Y.R. Boisclair, and J.K. Drackley. 2011. Prepartum dietary energy intake affects metabolism and health during the periparturient period primiparous and multiparous Holstein cows J. Dairy Sci. 94:1385-1400.

Reynolds, C.K. 2004. Effects of postrumen starch infusion on milk production and energy metabolism in dairy cows. J. Dairy Sci. 84:2250-2259.

Sibbald, I.R.1976. A bioassay for true Metabolizable energy in feeding stuffs. Poult. Sci. 55:303-308.

ACKNOWLEDGEMENTS

INTA Argentina Experimental Stations: Santiago del Estero, Pergamino, and Manfredi