http://dx.doi.org/10.15446/rfmvz.v62n3.54937

Rev Med Vet Zoot. 62(3), septiembre - diciembre 2015: 10-17 Investigación

ADMINISTRATION OF EARLY POST-PARTUM ORAL DRENCH IN DAIRY COWS: EFFECT ON METABOLIC PROFILE

R. Schallenberger Gonçalves[1], F. Cardoso, F. de Souza Guagnini[2], L. J. Reyes Castañeda[3], F. Gonzalez[4]

Artículo recibido: 26 de mayo de 2015 . Aprobado: 31 de julio de 2015

ABSTRACT

Some prophylactic treatments have been proposed in high-yielding dairy cattle in order to minimize the effects of negative energy balance and some disturbances such as hypocalcaemia and ketosis. The objective of this study was to evaluate the effects of two doses of Drench within 24 h after calving on the metabolic profile and prevention of ketosis. A total of 48 cows from a herd in Rio Grande do Sul state (southern Brazil) was used in the study. The animals were randomly selected and treated orally with Drench (N= 32, propylene glycol, electrolytes and choline in 40 L of water) and water (N= 16) used as control. Blood samples were collected by blood coccygeal venipuncture through a vacutainer plain system tubes. Biochemical determinations were performed in serum (albumin, urea, cholesterol, triglycerides, non-esterified fatty acids -NEFA-, calcium, phosphorus, magnesium, aspartate transaminase -AST- and gammaglutamyl-transferase -GGT-) and a cow-side determination of beta-hydroxybutyrate (BHB) was performed using the Abbot blood Precision Xtra system. All cows in the experiment had their milk production controlled. The Drench treatment produces a tendency to a better milk yield (32.5 vs 29.6 L/cow/day) and helps to prevent subclinical ketosis, as indicated by a lesser prevalence of subclinical ketosis (29.7% vs 37.2%) and mean values of BHB (1.19 vs 1.27 mmol/L) as well as a lesser lipolysis as indicated by NEFA values (509 vs 1.560 µmol/L). The other components of the metabolic profile did not have substantial effects between treatments. In short, on the conditions of the present work, the Drench treatment is an effective management tool for prevention of subclinical ketosis and severe lipolysis.

Key-words: beta- hydroxybutyrate, ketosis, NEFA, prevention.

[1] Department of Animal Sciences, University of Illinois, USA.

[2] Cooperativa Santa Clara, Brasil.

[3] Universidad de Los Llanos, Colombia.

[4] Faculdade de Veterinária, Universidade Federal do Rio Grande do Sul. Av. Bento Gonçalves, 9090 - Agronomia - Porto Alegre, Rio Grande do Sul, Brasil

* Autor para correspondencia: felixgonzalez.ufrgs@gmail.com

ADMINISTRACIÓN ORAL DE DRENCH EN EL POSPARTO TEMPRANO EN VACAS LECHERAS: EFECTO SOBRE EL PERFIL METABÓLICO

RESUMO

Alguns tratamentos profiláticos têm sido propostos em vacas leiteiras de alta produção a fim de minimizar os efeitos do balanço energético negativo e alguns distúrbios como hipocalcemia e cetose. Os objetivos desse estudo foram avaliar os efeitos da administração de duas doses de Drench em até 24 h depois do parto sobre o perfil metabólico e a prevenção da cetose. Um grupo de 48 vacas de um rebanho no Rio Grande do Sul foi usado no estudo. Os animais foram selecionados aleatoriamente e tratado oralmente com Drench (N= 32, propileno-glicol, eletrólitos e colina em 40 L de água) e água (N= 16) usado como controle. Amostras de sangue foram coletadas por punção venosa coccígea, através do sistema *vacutainer*, em tubos sem anticoagulante. Foram realizadas determinações bioquímicas no soro (albumina, ureia, colesterol, triglicerídeos, ácidos graxos não esterificados -NEFA-, cálcio, fósforo, magnésio, aspartato aminotransferase -AST- e gama-glutamil-transferase -GGT-), e na propriedade, ao pé da vaca, foi feita a determinação do beta-hidroxibutirato (BHB) no sangue com o sistema Abbot Precision Xtra. Todas as vacas do experimento tiveram sua produção leiteira controlada. O tratamento com Drench causou tendência a uma melhor produção de leite (32.5 vs 29.6 L/vaca/dia) e ajudou a prevenir a cetose subclínica, como indicou a menor prevalência (29.7% vs 37.2%) e menores médias de BHB (1.19 vs 1.27 mmol/L) bem como menor lipólise, indicado pelos valores de NEFA (509 vs 1.560 µmol/L). Os demais componentes do perfil metabólico não tiveram efeitos substanciais entre os tratamentos. Em suma, nas condições do presente trabalho, o tratamento com Drench pode ser considerado eficaz como ferramenta para a prevenção de cetose subclínica e da lipólise severa.

Palavras-chave: ácidos graxos não-esterificados, beta-hidroxibutirato, cetose, prevenção.

INTRODUCTION

The transition period in dairy cows, comprising the period from 21 days before to 21 days after calving, is characterized by a great metabolic stress associated to a 30% reduction in feed intake and an increase in nutritional requirements and lipomobilization (Drackley *et al*. 2001). This period is considered of high risk to develop metabolic disorders which compromise the cow's health (Herdt *et al*. 2000). These events may induce energy, protein and mineral deficiencies which frequently result in disorders like hypocalcemia, puerperal hemoglobinuria and ketosis (Cameron *et al*. 1998). In dairy cows, blood concentrations of beta-hydroxybutyrate (BHB) and non-esterified fatty acids (NEFA) have been considered sensitive indicators of severe negative energy balance (NEB) (Suthar *et al*. 2013). Many studies have demonstrated that high blood concentrations of these metabolites are related to the onset of several metabolic diseases (LeBlanc *et al*. 2005, Ospina *et al*. 2010a), and also to decreased productividy (Duffield *et al*. 2009) and reproductive failure (Walsh *et al*. 2007, Ospina *et al*. 2010b).

Some prophylactic treatments have been proposed in order to minimize the effects of NEB and to prevent some di-

sorders like hypocalcemia, ketosis and perinatal diseases (Studer *et al*. 1993, Goff and Horst 1994), with the aim of obtaining adequate milk yield and reproductive performance (Miyoshi *et al*. 2001). An important prophylactic strategy to prevent puerperal disorders in dairy cows is the use of a "Drench" (a mixture of electrolytes, glucose precursors and calcium), which increases serum calcium levels, and minimizes the energy deficiency, rehydrates the animal and corrects probable hydro-electrolytic and acid-base imbalances (Enemark *et al*. 2009, Pickett *et al*. 2003, Stokes and Goff 2001).

The present study aimed at evaluating the early application of an oral Drench solution (immediately after calving and 24 h after) in relation to the metabolic profile and its potential for preventing subclinical ketosis in dairy cows from Southern Brazil.

MATERIAL AND METHODS

All procedures in this experiment were approved by the Ethical Committee of the Federal University of Rio Grande do Sul (project nº 25553). The cows in this study came from a herd in a semi-confinement system located in the Rio Grande do Sul state (Southern Brazil). A total of 48 multiparous cows were used (Table 1). The cows were milked twice daily and fed with a total mixed ration formulated according to the nutritional requirements established by the National Research Council (NRC 2001).

The cows were randomly distributed on the day of calving in one of the two following treatments: (1) Drench (N = 32): receiving 40 L of warm water with 500 g calcium chloride, 300 mL propilene-glycol, 250 g de potassium chloride, 250 g de magnesium sulphate, 50 g de sodium chloride and 100 g protected choline. All cows received this treatment on the day of calving and 24 hours later using a siphon esophageal tube. (2) Control (N = 16): receiving 40 L of warm water in the same condition of administration of the Drench group.

Blood samples were collected twice weekly after the morning milking during the first three weeks of lactation from the coccygeal vein in plain vacutainer tubes (BD, Brazil) in order to determine a metabolic profile. The samples were centrifuged (2,500 rpm, 10 min) after the clot formation (1 h after sampling) and the serum was frozen until biochemical analysis. The following components were determined: albumin, urea, cholesterol, triglycerides, non-esterified fatty acids (NEFA), calcium, magnesium, phosphorus, and the enzymes aspartate transaminase (AST) and gamma-glutamyl transferase (GGT). All metabolites were determined using an automated spectrophotometer (Autoanalyzer CM 200, Wiener Lab, Argentine) and commercial kits (Labtest, Brazil). Additionally, whole blood samples were collected at the same sampling times in order to determine beta-hydroxybutyrate (BHB) in the farm using a portable system (Precision Xtra, Abbott), according to the manufacturer´s instructions.

For the statistical analysis the data were included in an Excel worksheet and then exported to the SPSS v. 20 program. All variables were described as mean and standard deviation and compared by the Student t test for independent samples for treatments. The level of significance for the Student t tests was 0.05.

TABLE 1. Husbandry characteristics of the herd used in the experiment.

Characteristics	
System production	Semi-confinement
Milking cows	90
N (experimental)	48
Mean body weight (kg)	660
Mean milk yield (L/day)	36
Mean milk yield (L/lactation)	12,935
Feed offered (kg dry matter/day)	23.81
Feed composition (kg of dry matter)	
Corn silage	10.26
Ryegrass / oat silage	3.0
Ryegrass hay	0.88
Corn	3.92
Soybean meal	4.11
Wheat meal	0.27
Extruded soybean	0.88
Minerals + vitamins	0.49
Forage:grain ratio	59:41
Feed analysis	
NDF (%)	29.5
Protein (%)	17.5
Net energy (Mcal/kg)	1.58

RESULTS AND DISCUSSION

The use of Drench, defined as oral forced administration of different compounds, has grown in the past years as a prophylactic tool for minimize calcium and energy deficiencies in early postpartum dairy cows (Stokes and Goff 2001). The present work tested a double administration of a Drench solution 24 h after calving in order to check its potential use for preventing ketosis in high-yielding dairy cows from southern Brazil. Calcium salts and glucose precursors as propylene glycol have gained large use based on the concept that Drench components do not degrade in the rumen and reach the liver faster than other glucose precursors such as propionate (Stokes and Goff 2001). The inclusion

of other compounds in the Drench (water, minerals, choline) may contribute to minimize dehydration, electrolytic and energy imbalances and accumulation of triglycerides in the liver (Enemark 2009), which lead to higher production. In the present work, there was a tendency (P = 0.09) of the Drench group cows to have a higher individual milk yield (32.5 ± 7,4 L/day) throughout the observed period (three weeks of lactation), compared to the control group (29.6 ± 7,7 L/day).

The most important serum metabolites used for evaluating lipolysis and ketone bodies synthesis are NEFA and BHB, respectively (Gonzalez *et al*. 2010). The metabolic profile is also a useful tool to evaluate treatments affecting metabolic responses in dairy cows (Gonzalez 1997). In the present work, the mean level of BHB of the cows treated with water (Table 2) may be considered as reaching a threshold for subclinical ketosis (BHB > 1.2 mmol/L, McArt *et al*. 2012). Although significant differences in BHB values were not detected, the higher value of BHB in cows receiving water and the fact that the prevalence of subclinical ketosis (BHB > 1.2 mmol/L) in this group was higher (37.2%) than the prevalence in the cows treated with Drench (29.7%), indicate that the treatment reduces the production of BHB. Other studies in Brazil reported subclinical ketosis prevalence in Holstein herds of 11.2% (Campos *et al*. 2005), 17.5% (Corassin 2004) and 24% (Garcia *et al*. 2011), while, in the United States, Melendez and Risco (2005) reported values of 20.4% and McArt *et al*. (2012) cited 43.2% and, in Europe, Suthar *et al*. (2013) established that subclinical ketosis may affect up to 36.6% of milking cows. The different prevalence indexes of subclinical ketosis reported in the literature are related to the cut-off point of serum BHB adopted, that may vary from 1.2 to 1.4 mmol/L.

TABLE 2. Mean (standard deviation) of the metabolic profile during early lactation in dairy cows treated with Drench in a herd from Rio Grande do Sul (southern Brazil).

Metabolite	Treatment	
	Water (N= 32)	Drench (N= 16)
Albumin (g/L)	27.0 (3.9)	26.1 (4.1)
Urea (mg/dL)	28.4[a] (8.4)	30.3[b] (9.3)
Cholesterol (mg/dL)	130 (36.7)	127 (35.0)
Triglycerides (mg/dL)	16.4 (8.2)	15.6 (9.7)
Beta-OH-butyrate (mmol/L)	1.27 (0.77)	1.19 (0.72)
NEFA (µmol/L)	1560[a] (799)	509[b] (471)
AST (U/L)	50.9[a] (21.7)	56.8[b] (25.2)
GGT (U/L)	22.2[a] (7.9)	26.7[b] (14.9)
Calcium (mg/dL)	9.14 (1.63)	9.11 (1.82)
Phosphorus (mg/dL)	5.57[a] (1.57)	5.88 [b] (1.53)
Magnesium (mg/dL)	2.53[a] (0.68)	2.35 [b] (0.50)

Within a row, different superscripts indicate a significant difference ($p < 0.05$).
NEFA: Non-esterified fatty acids, AST: aspartate transferase, GGT: gamma-glutamyl transferase.

Negative energy balance in high-yielding dairy cows is also responsible for increasing serum NEFA values above 400 µmol/L (Oetzel 2004), while values above 700 µmol/L indicate high risk of ketosis. In this perspective, the cows receiving water instead of Drench in this experiment are at a greater risk of suffering ketosis, as the mean serum NEFA value (1.560 µmol/L) and the prevalence of subclinical ketosis found (38.5%) show.

The comparison of NEFA values between treatments shows that the Drench was effective in diminishing the serum concentration of BHB and NEFA, indicating its potential use as prophylactic tool for reducing lipolysis and ketone bodies generation in high-yielding dairy cows. The propylene glycol, one of the main components of Drench, has been proven to lower the effects of a negative energy balance, typical of high-yielding dairy cows (Studer *et al*. 1993; Formigoni *et al*. 1996), and to reduce the risk of ketosis and liver lipidosis (Studer *et al*. 1993). In a review of 12 studies concerning the effect of propylene glycol on the metabolism of dairy cows, Nielsen and Ingvartsen (2004) pointed out the efficacy of this treatment in reducing the risk of ketosis and in the increase in milk yield.

Choline, another ingredient of the tested Drench in this work, is useful in enhancing the synthesis of hepatic lipoproteins and, consequently, in diminishing liver esteatosis (Cooke *et al*. 2007). The assessment of the degree of liver esteatosis in dairy cows can be supported by some metabolic profile components, mainly the serum activity of hepatic enzymes (AST, GGT, GLDH) and the concentration of albumin, cholesterol and triglycerides (Gonzalez *et al*. 2010). In the present work, even though some differences between groups were observed in the values of albumin, AST and GGT, all those values fell into the reference range and do not configure evidence of liver lipidosis or any other disorder. As a general rule, hepatic lipidosis is characterized by a decrease in albumin, cholesterol and triglycerides and an increase in liver enzymes (Bertoni and Trevisi 2013).

In conclusion, the Drench solution containing propylene glycol, minerals (Ca, Mg), electrolytes (Na, K, Cl) and choline, administered twice after calving, is useful in preventing subclinical ketosis and severe lipolysis in high-yielding dairy cows.

REFERENCES

Bertoni G, Trevisi E. 2013. Use of the liver activity index and other metabolic variables in the assessment of metabolic health in dairy herds. Vet. Clin. Food Anim. Pract. 29(2): 413-431. Doi: 10.1016/j.cvfa.2013.04.004

Cameron RE, Dyk PB, Herdt TH, Kaneene JB, Miller R, Bucholtz HF, Liesman JS, Vandehaar MJ, Emery RS. 1998. Dry cow diet, management, and energy balance as risk factors for displaced abomasum in high producing dairy herds. J. Dairy Sci. 81(1): 132–139. Doi: 10.3168/jds.S0022-0302(98)75560-2.

Campos R, Gonzalez F, Coldebella A, Lacerda L. 2005. Determinação de corpos cetônicos na urina como ferramenta para o diagnóstico rápido de cetose subclínica bovina e relação com a composição do leite. Arch. Vet. Sci. 10(2): 49-54.

Cooke RF, Silva Del Rio N, Caraviello DZ, Bertics SJ, Ramos MH, Grummer RR. 2007. Supplemental choline for prevention and alleviation of fatty liver in dairy cattle. J. Dairy Sci. 90(5): 2413–2418. Doi: 10.3168/jds.2006-028.

Corassin CH. 2004. Determinação e avaliação de fatores que afetam a produtividade de vacas leiteiras: aspectos sanitários e produtivos. [Tese de Doutorado]. [Piracicaba, São Paulo, Brasil] Universidade de São Paulo.

Drackley JK, Overton TR, Douglas GN. 2001. Adaptations of glucose and long chain fatty acid metabolism in liver of dairy cows during the periparturient period. J. Dairy Sci. 84: E100–E112. Doi: 10.3168/jds.S0022-0302(01)70204-4.

Duffield TF, Lissemore KD, McBride BW, Leslie KE. 2009. Impact of hyperketonemia in early lactation dairy cows on health and production. J. Dairy Sci. 92(2): 571–580. Doi: 10.3168/jds.2008-1507.

Enemark JM, Schmidt HB, Jakobsen J, Enevoldsen C. 2009. Failure to improve energy balance or dehydration by drenching transition cows with water and electrolytes at calving. Vet. Res. Commun. 33(2): 123-137. Doi: 10.1007/s11259-008-9079-1.

Formigoni AM, Cornil MC, Prandi A, Mordenti A, Rossi A, Portetelle D, Renaville R. 1996. Effect of propylene-glycol supplementation around parturition on milk yield, reproduction performance and some hormonal and metabolic characteristics in dairy cows. J. Dairy Res. 63(1): 11–24. Doi: 10.1017/S0022029900031502.

Garcia AMB, Cardoso FC, Campos R, Thedy DX, Gonzalez FHD. 2011. Metabolic evaluation of dairy cows submitted to three different strategies to decrease the effects of negative energy balance in early postpartum. Pesq. Vet. Bras. 31 (supl. 1): 11-17. Doi: 10.1590/S0100-736X2011001300003.

Goff JP, Horst RL. 1994. Calcium salts for treating hypocalcemia: carrier effects, acid-base balance, and oral versus rectal administration. J. Dairy Sci. 77(5): 1451–1456. Doi: 10.3168/jds.S0022-0302(94)77083-1.

Gonzalez FHD. 1997. O perfil metabólico no estudo de doenças da produção em vacas leiteiras. Arq. Fac. Vet. UFRGS 25: 13-33.

Gonzalez FD, Muiño R, Pereira V, Campos R, Benedito JL. 2010. Relationships among blood indicators of lipomobilization and hepatic function during early lactation in high-yielding dairy cows. J. Vet. Sci. 12(3): 251-255. Doi: 10.4142/jvs.2011.12.3.251.

Herdt TH. 2000. Ruminant adaptation to negative energy balance. Influences on the etiology of ketosis and fatty liver. Vet. Clin. North Am. Food Anim. Pract. 16(2): 215-230.

LeBlanc SJ, Leslie KE, Duffield TF. 2005. Metabolic predictors of displaced abomasum in dairy cattle. J. Dairy Sci. 88(1): 159–170.

McArt JAA, Nydam DV, Oetzel GR. 2012. Epidemiology of subclinical ketosis in early lactation dairy cattle. J. Dairy Sci. 95(9): 5056–5066. Doi: doi:10.3168/jds.2012-5443.

Melendez P, Risco CA. 2005. Management of transition cows to optimize reproductive efficiency in dairy herds. Vet. Clin. North Am. Food Anim. Pract. 21(2): 485–501. Doi: 10.1016/j.cvfa.2005.02.008.

Miyoshi S, Pate JL, Palmquist DL. 2001. Effect of propylene glycol drenching on energy balance, plasma glucose, plasma insulin, ovarian function and conception in dairy cows. Anim. Reprod. Sci. 68(1-2): 29–43. Doi: 10.1016/S0378-4320(01)00137-3.

Nielsen NI, Ingvartsen KL. 2004. Propylene glycol for dairy cows: A review of the metabolism of propylene glycol and its effects on physiological parameters, feed intake, milk production and risk of ketosis. Anim. Feed Sci. Technol. 115(3-4): 191–213. Doi: 10.1016/j.anifeedsci.2004.03.008.

[NRC] National Research Council. 2001. Nutrient Requirements of Dairy Cattle. 7.° ed. Washington, DC: National Academy Press. 408 p.

Oetzel GR. Monitoring and testing dairy herds for metabolic disease. 2004. Vet. Clin. North Am. Food Anim. Pract. 20(3): 651-674. Doi: 10.1016/j.cvfa.2004.06.006.

Ospina PA, Nydam DV, Stokol T, Overton TR. 2010a. Evaluation of nonesterified fatty acids and β-hydroxybutyrate in transition dairy cattle in the northeast United States: Critical thresholds for prediction of clinical diseases. J. Dairy Sci. 93(2): 546–554. Doi: 10.3168/jds.2009-2277.

Ospina PA, Nydam DV, Stokol T, Overton TR. 2010b. Associations of elevated nonesterified fatty acids and β-hydroxybutyrate concentrations with early lactation reproductive performance and milk production in transition dairy cattle in the northeastern United States. J. Dairy Sci. 93(4): 1596–1603. Doi: 10.3168/jds.2009-2852.

Pickett MM, Piepenbrink MS, Overton TR. 2003. Effects of propylene glycol or fat drench on plasma metabolites, liver composition, and production of dairy cows during the periparturient period. J. Dairy Sci. 86(6): 2113-2121. Doi: 10.3168/jds.S0022-0302(03)73801-6.

Stokes RS, Goff JP. 2001. Case study: evaluation of calcium propionate and propylene glycol administrated in to esophagus of dairy cattle at calving. Profes. Anim. Scient. 17(2): 115-122.

Studer VA, Grummer RR, Bertics SJ, Reynolds CK. 1993. Effect of prepartum propylene glycol administration on periparturient fatty liver in dairy cows. J. Dairy Sci. 76(10): 2931–2939. Doi: 10.3168/jds.S0022-0302(93)77633-X.

Suthar VS, Canelas-Raposo J, Deniz A, Heuwieser W. 2013. Prevalence of subclinical ketosis and relationships with postpartum diseases in European dairy cows. J. Dairy Sci. 96(5): 2925-2938. Doi: 10.3168/jds.2012-6035.

Walsh RB, Walton JS, Kelton DF, LeBlanc SJ, Leslie KE, Duffield TF. 2007. The effect of subclinical ketosis in early lactation on reproductive performance of postpartum dairy cows. J. Dairy Sci. 90(6): 2788–2796. Doi: 10.3168/jds.2006-560.

Article citation:

Schallenberger Gonçalves R, Cardoso F, de Souza Guagnini F, Reyes Castañeda LJ, Gonzalez F. 2015. Administration of early post-partum oral drench in dairy cows: effect on metabolic profile [Administración oral de drench en el posparto temprano en vacas lecheras: efecto sobre el perfil metabólico]. Rev Med Vet Zoot. 62(3): 10-17. Doi: http://dx.doi.org/10.15446/rfmvz.v62n3.54937.