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Effect of dietary cation-anion difference on performance of lactating dairy cows and stability of milk proteins

C. M. M. R. Martins,* M. A. Arcari,* K. C. Welter,† A. S. Netto,† C. A. F. Oliveira,‡ and M. V. Santos*[1]
*Department of Nutrition and Animal Production, School of Veterinary Medicine and Animal Sciences,
†Department of Animal Science, and
‡Department of Food Engineering, School of Food Engineering and Animal Science, University of São Paulo, Brazil 13635-900

ABSTRACT

Casein micelle stability is negatively correlated with milk concentrations of ionic calcium, which may change according to the metabolic and nutritional status of dairy cows. The present study aimed to evaluate the effect of dietary cation-anion difference (DCAD) on concentrations of casein subunits, whey proteins, ionic calcium, and milk heat and ethanol stability. Sixteen Holstein cows were distributed in 4 contemporary 4 × 4 Latin square designs, which consisted of 4 periods of 21 d and 4 treatments according to DCAD: 290, 192, 98, and −71 mEq/kg of dry matter (DM). The milk concentrations of ionic calcium and κ-casein were reduced as DCAD increased, whereas the milk urea nitrogen and β-lactoglobulin concentrations were increased. As a result of these alterations, the milk ethanol stability and milk stability during heating at 140°C were increased linearly with increasing DCAD [Y = 74.87 (standard error = 0.87) + 0.01174 (standard error = 0.0025) × DCAD (mEq/kg of DM) and Y = 3.95 (standard error = 1.02) + 0.01234 (standard error = 0.0032) × DCAD (mEq/kg of DM), respectively]. In addition, 3.5% fat-corrected milk and fat, lactose, and total milk solids contents were linearly increased by 13.52, 8.78, 2.5, and 2.6%, respectively, according to DCAD increases from −71 to 290 mEq/kg of DM, whereas crude protein and casein content were linearly reduced by 4.83 and 4.49%, respectively. In conclusion, control of metabolic changes in lactating dairy cows to maintain blood acid-base equilibrium plays an important role in keeping milk stable to ethanol and during heat treatments.

Key words: casein, dietary cation-anion difference, ionic calcium, milk ethanol stability

INTRODUCTION

Stability of milk proteins is an important issue in the dairy industry, especially for the manufacture of milk products that require intense heat treatments, such as UHT and powdered milk. Also, high raw milk stability is needed to avoid losses to dairy farmers due to price penalty or rejection of milk, to prevent coagulation of milk during heat treatment (Fischer et al., 2012), and also to reduce the age-related gelation of heat-treated milks during storage (García-Risco et al., 1999). Thus, the milk ethanol stability (**MES**) test is still used worldwide in receiving platforms of dairy plants to predict the stability of milk proteins (Fischer et al., 2012).

The casein micelle in milk is formed by casein subunits (α, β, and κ) interconnected by micellar calcium phosphate (Walstra, 1999). The calcium, besides the colloidal phase, is also present in milk in a free form (ionic calcium), which is negatively correlated with casein micelle stability (Barros et al., 1999). The increase in milk concentrations of ionic calcium (**iCa**) may reduce the negative charges of the casein micelles and the strength of electrostatic repulsion between them, which reduces casein resistance to form clots during contact with ethanol or during milk heat treatments (Barros et al., 1999). The α- and β-CN are unstable when in contact with milk iCa. However, κ-CN, which is located in the outer layer of the micelle, is hydrophilic and stable to iCa reaction and therefore protects the micelle hydrophobic core (composed of α- and β-CN) from water contact and iCa ionization (Creamer et al., 1998; Walstra, 1999). Thus, the structural arrangement of α-, β-, and κ-CN in the micelle, the milk concentrations of divalent cations, and the electrostatic repulsion strength between micelles may determine the heat stability (Jeurnink and De Kruif, 1995; Barros et al., 1999; Fischer et al., 2012), the formation of β-LG/κ-CN complexes on heating, and, subsequently, formation of irreversible gel in UHT milk during storage (McMahon, 1995; García-Risco et al., 1999).

High incidences of unstable milk showing normal acidity values have been reported worldwide, especially in countries using UHT as the main form of fluid milk

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[1]Corresponding author: mveiga@usp.br