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Management, nutrition, and lactation performance are related to bulk tank milk de novo fatty acid concentration on northeastern US dairy farms

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ABSTRACT

This study investigated the relationship of management practices, dietary characteristics, milk composition, and lactation performance with de novo fatty acid (FA) concentration in bulk tank milk from commercial dairy farms with Holstein, Jersey, and mixed-breed cows. It was hypothesized that farms with higher de novo milk FA concentrations would more commonly use management and nutrition practices known to optimize ruminal conditions that enhance de novo synthesis of milk FA. Farms (n = 44) located in Vermont and northeastern New York were selected based on a history of high de novo (HDN; 26.18 ± 0.94 g/100 g of FA; mean ± standard deviation) or low de novo (LDN; 24.19 ± 1.22 g/100 g of FA) FA in bulk tank milk. Management practices were assessed during one visit to each farm in March or April, 2014. Total mixed ration samples were collected and analyzed for chemical composition using near infrared spectroscopy. We found no differences in days in milk at the farm level. Yield of milk fat, true protein, and de novo FA per cow per day were higher for HDN versus LDN farms. The HDN farms had lower freestall stocking density (cows/stall) than LDN farms. Additionally, tiestall feeding frequency was higher for HDN than LDN farms. No differences between HDN and LDN farms were detected for dietary dry matter, crude protein, neutral detergent fiber, starch, or percentage of forage in the diet. However, dietary ether extract was lower for HDN than LDN farms. This research indicates that overcrowded freestalls, reduced feeding frequency, and greater dietary ether extract content are associated with lower de novo FA synthesis and reduced milk fat and true protein yields on commercial dairy farms.

Key words: de novo fatty acid, feeding management, milk fat, stocking density, true protein

INTRODUCTION

Milk fat and true protein content are primary drivers of income over feed cost on commercial dairy farms (Bailey et al., 2005). In bulk tank milk samples taken 3 to 20 times per month on 430 commercial farms for 15 mo, Barbano et al. (2014) identified a positive correlation between de novo milk fatty acids (**FA**; C4 to C14) concentration and milk fat and true protein content. Consequently, identifying management and dietary factors that are related to milk de novo FA concentration may be useful for making recommendations to dairy producers to increase bulk tank milk fat and protein content and improve the income over feed cost of dairy farms.

For high-producing Holstein cows, de novo FA typically account for 18 to 28% of the total FA in milk fat (Jensen, 2002). Milk FA profiles vary due to animal factors such as breed and genetics (Soyeurt et al., 2006) and stage of lactation (Lynch et al., 1992; Stoop et al., 2009). In addition, nutritional and management practices may influence milk FA profiles and are the predominant environmental factors that affect milk de novo FA synthesis among cows of similar breed and stage of lactation (Palmquist et al., 1993; Bauman and Griinari, 2003).

Diets high in fermentable carbohydrates and PUFA may result in depressed milk fat through a shift toward the so-called alternate rumen biohydrogenation pathway, leading to the formation of FA isomers, which downregulate the expression of genes related to de novo FA synthesis (Harvatine and Bauman, 2011). Dietary fat supplementation may also influence milk fat composition by directly providing substrate for preformed milk FA (Stoffel et al., 2015), although the extent of variation is limited by the melting point of the milk fat globule (Toral et al., 2013). In addition, manage-

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ment practices that change feeding behavior, such as overstocking of the feed bunk (Sova et al., 2013), may increase a cow's risk for low ruminal pH (French and Kennelly, 1990) and lead to a reduction in milk fat content (Allen, 1997). Consequently, bulk tank milk de novo FA content may serve as an indicator of ruminal fermentation conditions that prevail within the herd.

Most previous research has evaluated the effects of just one, or a small number, of dietary and management factors on individual cow milk FA profiles and has been reviewed elsewhere (Grummer, 1991; Palmquist et al., 1993; Neville and Picciano, 1997; Harvatine et al., 2009). These controlled experiments have been crucial to understanding the factors that affect milk de novo FA content. On a bulk tank basis, Coppa et al. (2013) predicted FA composition using data that described the source and proportion of forages in the diet. However, further research is still needed to describe the relationship of farm management practices and dietary chemical composition with bulk tank de novo FA content on commercial dairy farms. A goal of this type of research is to assess the value of using bulk tank milk FA composition as a herd management tool in addition to individual cow milk FA.

Therefore, the objective of the current study was to understand the relationship of farm management, dietary composition, milk composition, and lactation performance with milk de novo FA content and yield in bulk tank milk from commercial dairy farms in Vermont and northeastern New York. We hypothesized that bulk tank milk from farms that more commonly use management practices and dietary strategies known to optimize ruminal conditions will produce milk with higher de novo FA content.

MATERIALS AND METHODS

On-Farm Data Collection

Commercial dairy farms (n = 44) located in Vermont and northeastern New York were enrolled in the study. Eligible farms were members of the St. Albans Cooperative Creamery (St. Albans, Vermont). Farms were categorized as high de novo (**HDN**; 26.18 ± 0.94 g/100 g of FA; mean ± SD) or low de novo (**LDN**; 24.19 ± 1.22 g/100 g of FA) based on the mean bulk tank milk de novo FA concentration from September 2013 to February 2014 (Table 1). All farms in the St. Albans Cooperative were ranked from high to low for de novo FA (expressed as FA/100 g of FA) for the 6 mo before the study. Farms were identified by the St. Albans Cooperative as predominantly Holstein or predominantly Jersey farms. The objective was to visit 20 HDN and 20 LDN farms; however, additional farms were contacted because some farms (n = 12) were not interested in participating in the study or were unable to be contacted by phone. Ultimately, 21 HDN farms and 23 LDN farms were visited once between March 21, 2014, and April 30, 2014, and all farms were included in the final data set.

During each farm visit, trained research personnel worked with a farm owner or manager to complete a questionnaire. Breed of cows on the farm was self-reported by the farm owner or manager and classified as percentage of the farm that was Holsteins. The number of cows milking and average bulk tank milk shipped for the month of the farm visit was used to determine the mean milk yield per cow. Frequency of fresh feed delivery, number of lactating groups housed separately, and

Table 1. Milk composition data representing monthly mean milk composition by farm from September 2013 to February 2014 that was used to select high de novo (HDN) and low de novo (LDN) farms to participate in the study

	HDN			LDN		
Milk component	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum
Fat, %	4.55 ± 0.51	3.75	5.34	3.90 ± 0.23	3.51	4.38
True protein, %	3.50 ± 0.29	3.11	4.08	3.16 ± 0.17	2.90	3.45
De novo fatty acids[1]						
g/100 g of milk	1.13 ± 0.16	0.88	1.40	0.90 ± 0.08	0.80	1.08
g/100 g of fatty acids	26.18 ± 0.94	24.20	28.00	24.19 ± 1.22	21.70	26.03
Mixed fatty acids[2]						
g/100 g of milk	1.65 ± 0.21	1.31	2.04	1.36 ± 0.09	1.18	1.52
g/100 g of fatty acids	38.24 ± 0.98	35.65	39.80	36.85 ± 1.44	32.18	38.73
Preformed fatty acids[3]						
g/100 g of milk	1.52 ± 0.14	1.31	1.75	1.43 ± 0.09	1.33	1.70
g/100 g of fatty acids	35.58 ± 1.41	33.24	38.01	38.80 ± 2.09	35.94	45.82

[1]C4 to C14.

[2]C16, C16:1, and C:17.

[3]Greater than or equal to C18.