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Feeding reduced-fat dried distillers grains with solubles to lactating Holstein dairy cows does not alter milk composition or cause late blowing in cheese

E. D. Testroet,* D. C. Beitz,† M. R. O'Neil,† A. L. Mueller,‡ H. A. Ramirez-Ramirez,† and S. Clark§[1]
*Department of Animal Sciences, Washington State University, Pullman 99164
†Department of Animal Science, Iowa State University, Ames 50011
‡Purina Animal Nutrition, Rochester, MN 55904
§Department of Food Science and Human Nutrition, Iowa State University, Ames 50011

ABSTRACT

Feeding dried distillers grains with solubles (DDGS) to lactating dairy cows has been implicated as a cause of late blowing defects in the production of Swiss-style cheeses. Our objectives were (1) to test the effect of feeding reduced-fat DDGS (RF-DDGS; ~6% fat) to lactating dairy cows on the composition of milk and on the suitability of the milk for production of baby Swiss cheese and (2) to evaluate the effect of diet on cow lactation performance. Lactating Holstein dairy cows were fed both dietary treatments in a 2 × 2 crossover design. Cows were housed in a 48-cow freestall pen equipped with individual feeding gates to record feed intake. The control diet was a corn, corn silage, and alfalfa hay diet supplemented with mechanically expelled soybean meal. The experimental diet was the same base ration, but 20% (dry matter basis) RF-DDGS were included in place of the expelled soybean meal. The RF-DDGS diet was additionally supplemented with rumen-protected lysine; diets were formulated to be isoenergetic and isonitrogenous. Cows were allowed ad libitum access to feed and water, fed twice daily, and milked 3 times daily. For cheese production, milk was collected and pooled 6 times for each dietary treatment. There was no treatment effect on milk yield (35.66 and 35.39 kg/d), milk fat production (1.27 and 1.25 kg/d), milk fat percentage (3.65 and 3.61%), milk protein production (1.05 and 1.08 kg/d), lactose percentage (4.62 and 4.64%), milk total solids (12.19 and 12.28%), and somatic cell count (232.57 and 287.22 × 10^3 cells/mL) for control and RF-DDGS, respectively. However, dry matter intake was increased by treatment, which implied a reduction in feed efficiency. Milk protein percentage also increased (3.01 and 3.11%), whereas milk urea nitrogen decreased (14.18 and 12.99 mg/dL), indicating that protein utilization may be more efficient when cows are fed RF-DDGS. No differences in cheese were observed by a trained panel except cheese appearance; control cheese eyes were significantly, but not practically, larger than the RF-DDGS cheese. These results indicate that RF-DDGS can be effectively used in the rations of lactating Holstein cows with no deleterious effects on milk production and composition and metrics of the physiology of the cow (i.e., blood glucose and nonesterified fatty acids); however, feeding RF-DDGS increased dry matter intake, which decreased feed efficiency. Finally, feeding RF-DDGS did not negatively influence quality and suitability of milk for production of baby Swiss cheese.
Key words: efficiency, dried distillers grains with solubles, milk fat, protein utilization, sensory

INTRODUCTION

Feeding of conventional corn dried and wet distillers grains with solubles (**DG**) to ruminant animals has been studied and reviewed extensively (Klopfenstein et al., 2008; Schingoethe et al., 2009). However, some studies with lactation dairy cows report no changes in production metrics (Anderson et al., 2006; Sasikala-Appukuttan et al., 2008), whereas others report either positively or negatively altered milk composition or yield when DG are fed (Kleinschmit et al., 2006; Abdelqader et al., 2009). The discrepancies in results indicate that several factors influence milk production when incorporating DG in the rations and that there may be limitations that need to be considered. One problem with feeding conventional DG is that they contain approximately 13% ether extract, which comprises mainly corn oil, a rich source of UFA. This problem is multifaceted; inclusion of DG can result in diets that can exceed 5% lipid (DM basis), which can hinder fiber digestion (Zinn, 1989) due to toxic effects of rumen microbes (Maia et al., 2007) and altered biohydrogenation of UFA in the rumen. It is believed that ruminal microbes have a great capacity to reduce unsaturated hydrocarbons as a way to reduce the toxicity of UFA.

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[1]Corresponding author: milkmade@iastate.edu

Incomplete biohydrogenation of these hydrocarbons, however, can result in the production of bioactive forms of CLA, such as *trans*-10,*cis*-12 CLA, which inhibit de novo lipogenesis in the mammary gland (Baumgard et al., 2001). In addition, *trans*-10,*cis*-12 CLA is a bioactive compound that can decrease mRNA encoding for proteins important to mammary uptake of preformed fatty acids (Peterson et al., 2003). The aforementioned problem can result in milk fat depression, a condition characterized by decreased milk fat concentration and yield without concomitant alteration in milk yield or concentrations of other milk components (Bauman and Griinari, 2001). Recent modifications in oil extraction from DG (Majoni et al., 2011) for the biodiesel industry have led to the production of reduced-fat dried distillers grains with solubles (**RF-DDGS**), thus limiting availability of conventional dried distillers grains with solubles (**DDGS**). Currently, unless the value of corn oil decreases, it is not likely that conventional DDGS will be readily available and that-RF-DDGS will be the predominant co-product of the ethanol industry as a protein source (Pritchard, 2010). The decreased oil content of RF-DDGS could be an advantage for dairy producers, allowing them to include greater concentrations of this economical protein source with less risk for milk fat depression.

Research has shown positive results of lactation performance when RF-DDGS (~6% fat) are included in the rations of lactating dairy cows (Mjoun et al., 2010; Castillo-Lopez et al., 2014; Ramirez-Ramirez et al., 2016). However, no publications describe animal performance and milk processing properties when cows consume RF-DDGS, and reports are mixed about the effect of feeding DG on cheese quality (Houck et al., 2007; Manimanna Sankarlal et al., 2015). Dairy scientists have implicated the inclusion of DDGS in the rations of lactating dairy cows as a cause of late blowing defects, primarily through introduction of spores (Houck et al., 2007). Our research group investigated the effects on the quality of baby Swiss cheese when feeding full-fat DDGS (~13% fat) to dairy cows and observed no treatment effects in the quality of baby Swiss cheese when cows were fed up to 20% full-fat DDGS. Gas-forming spores were found in all TMR and all cheese samples regardless of treatment; however, spores were not found in any of the DDGS samples (Manimanna Sankarlal et al., 2015). Because decreasing the concentration of fat in DDGS can alleviate the risk of milk fat depression and because our previous research indicates that inclusion of DDGS in the diets of dairy cows does not cause late-blowing defects, we hypothesized that feeding RF-DDGS to lactating Holstein dairy cows supports milk production and composition with no further implications on quality of baby Swiss cheese. To further elucidate the effects of feeding DG on animal performance and milk processing properties, our objective was to feed RF-DDGS to lactating Holsteins and evaluate production responses, milk composition, and quality of cheese produced from that milk.

MATERIALS AND METHODS

Animals and Diets

All procedures were approved by the Iowa State University Animal Care and Use Committee. Thirty-six multiparous mid-lactation Holstein cows (BW = 680 ± 11 kg; 106 ± 27 DIM) were assigned randomly to 1 of 2 dietary treatment groups (n = 18 per group) in a 2 × 2 crossover design and were housed in a 48-cow freestall pen equipped with Calan gates (American Calan, Northwood, NH). The freestalls were bedded with reclaimed manure solids. The daily cleaning routine included rake grooming of stalls by hand and manure scraping using a skid loader with a scraper attachment every time cows were moved out of the pen for milking. Each of the 2 experimental periods lasted 35 d, with the first 14 d used as an acclimation or washout period to minimize carryover effects. Rations were formulated to meet or exceed nutrient requirements (NRC, 2001), to be isonitrogenous and isoenergetic (Tables 1 and 2), and to contain similar intestinally available AA concentrations based on the Cornell Net Protein and Carbohydrate System model with proprietary modifications (Purina Animal Nutrition LLC, Shoreview, MN). The control diet was a TMR based on corn, corn silage, and alfalfa hay supplemented with expeller soybean meal (SoyPlus, Landus Cooperative, Ames, IA) as a protein source. The RF-DDGS diet was formulated by using the same base ration as the control but with 20% of the DM being RF-DDGS (Poet Biorefining, Jewell, IA) containing approximately 6.0% fat in place of expeller soybean meal (Table 1). The RF-DDGS ration was supplemented with rumen-protected lysine (Kemin, Des Moines, IA) to make diets similar in available lysine (Table 1). Cows were housed together at the Iowa State University Dairy Farm (Ames, IA) in a 48-cow freestall pen and individually fed twice daily (0800 and 1600 h) through controlled-access gates (American Calan, Northwood, NH), allowing for approximately 10% refusals. Refusals were weighed and recorded daily. Feed ingredients in the TMR were mixed using a Patz V615 mixer (Patz Corp., Pound, WI). Cows were allowed ad libitum access to food and water except during their 3 daily milkings (8 h apart). Initially, cows were allowed to adapt to using the Calan gates before the start of the acclimation period. Additionally, individual milk