J. Dairy Sci. 97:5709–5717
http://dx.doi.org/10.3168/jds.2014-7896

The effects of supplementation with a blend of cinnamaldehyde and eugenol on feed intake and milk production of dairy cows

Emma H. Wall,*[1] Perry H. Doane,† Shawn S. Donkin,‡ and David Bravo*
*Pancosma SA, CH-1218 Geneva, Switzerland
†Archer Daniels Midland Company, Decatur, IL 62526
‡Department of Animal Sciences, Purdue University, West Lafayette, IN 47907

ABSTRACT

Plant extracts (PE) are naturally occurring chemicals in plants, and many of these molecules have been reported to influence production efficiency of dairy and beef animals. Two experiments were conducted to determine the effect of a PE additive (CE; an encapsulated blend of cinnamaldehyde and eugenol) on the milk production performance of lactating dairy cows across a range of doses. In experiment 1, 32 Holstein multi- and primiparous dairy cows in mid-lactation were assigned to no additive or supplementation with CE (350 mg/d; n = 16 cows/treatment) for 6 wk. In experiment 2, 48 Holstein multi- and primiparous dairy cows were assigned to no additive or supplementation with CE (200, 400, or 600 mg/d; n = 12 animals/treatment) for 8 wk. A 1-wk covariate period was included in both experiments. In both experiments, individual dry matter intake (DMI), milk production, milk composition, and somatic cell count were recorded daily. In experiment 1, CE was associated with an increase in DMI in both parity groups but an increase in milk production of multiparous cows only. In experiment 2, milk yield of multiparous cows was decreased at the 2 highest doses, whereas milk yield of primiparous cows was increased at the low and high doses of CE. These responses were accompanied by similar changes in DMI; therefore, CE did not affect feed efficiency. We observed no effect of CE on SCC or milk composition; however, treatment by parity interactions were detected for each of these variables that have not been described previously. Based on the results of these experiments, we conclude that a blend of cinnamaldehyde and eugenol can increase DMI and milk production in lactating dairy cows. In addition, environmental factors appear to influence the response to CE, including dose and parity, and these should be explored further.

Key words: dairy cow, feed additive, phytonutrient, plant extract

INTRODUCTION

One of the ways to improve milk production efficiency of dairy cows is to promote the efficient use of nutrients by rumen microbes and to minimize energy and protein losses during fermentation (Bauman et al., 1985; VandeHaar, 1998). The use of feed additives such as ionophore antibiotics (monensin) has proven to be a successful approach to increasing energy and protein utilization in the rumen, and to improving production efficiency of dairy animals (Sprott et al., 1988; Duffield et al., 2008a,b,c). The inclusion of antibiotics (including monensin) in animal feeds, however, is receiving increased criticism because of the potential for antibiotic residues and resistant strains of bacteria (Russell and Mantovani, 2002; Oliver et al., 2011). Therefore, recent efforts have been made to identify alternatives to antibiotics that can increase production efficiency of livestock, and some plant extracts (**PE**) appear to be potential candidates.

Plant extracts are naturally occurring chemicals synthesized by a variety of plant species. Many PE have antibacterial, antifungal, and antimicrobial properties designed to protect the plant of origin (Lewinsohn et al., 1991; Phillips and Croteau, 1999). In both dairy and beef production systems, there is interest in using PE as alternatives to antibiotics during disease (Bampidis et al., 2006) and as enhancers of feed efficiency (Benchaar et al., 2007; Santos et al., 2010; Tager and Krause, 2011; Tekippe et al., 2013). Several PE, including garlic oil, cinnamaldehyde (from cinnamon), and eugenol (from cloves), have been reported to influence rumen fermentation in vitro (Calsamiglia et al., 2007). Therefore, the potential may exist to use these molecules in dairy production systems to improve the efficiency of rumen fermentation to optimize milk production.

Importantly, the effects of many PE appear to be dose, diet, and pH dependent (Calsamiglia et al., 2007),

Received January 2, 2014.
Accepted June 7, 2014.
[1]Corresponding author: emma.wall@pancosma.ch

indicating that the source and dose of supplement provided, feeding management, and physiological state of the animal could affect the response of the animal to supplementation with a particular PE. With respect to dose, there are optimal doses for PE-based additives; if these doses are exceeded, negative effects might be observed. For example, the strong antimicrobial activity of thymol has been associated with varying effects on rumen fermentation in vitro, and this may be due to the fine line between an optimum and a toxic dose (Castillejos et al., 2006).

Several investigations have been conducted to determine the effect of various PE on production performance of dairy cows (Benchaar et al., 2007; Spanghero et al., 2009; Tassoul and Shaver, 2009; Santos et al., 2010; Tager and Krause, 2011; Tekippe et al., 2013). Feeding a blend of thymol, eugenol, vanillin, guaiacol, and limonene has been shown to increase DMI and FCM of lactating dairy cows fed a moderate dose (600 mg/d; Kung et al., 2008), whereas at greater doses it had no effect on intake or production but increased milk lactose content and rumen pH (750 mg/d; Benchaar et al., 2007) or increased rumen pH alone (2 g/d; Benchaar et al., 2006). In another study, feeding a high dose (1.2 g/d) of that same blend of PE was associated with a decrease in DMI and no effect on milk production, indicating improved feed efficiency (Tassoul and Shaver, 2009). Similarly, feeding cows a blend of eugenol, geranyl acetate, and coriander decreased DMI but increased milk fat yield, indicating a shift in energy usage for milk fat synthesis (Santos et al., 2010). Supplementation of lactating dairy cows with a blend of cinnamaldehyde, thymol, and orange peel fed at a moderate dose (640 mg/d) increased both the fat and protein contents of milk but had no effect on DMI or milk production (Spanghero et al., 2009). A blend of cinnamaldehyde and eugenol fed at moderate doses (~500 mg/d) had no effect on intake or performance when fed to lactating dairy cows (Tager and Krause, 2011; Tekippe et al., 2013), whereas at a very high dose (10 g/d) it negatively affected rumen fermentation (Tager and Krause, 2011). Clearly, many of these experiments confirm the potential effects of PE to influence lactation performance of dairy cows; however, they also confirm the observations of previous in vitro experiments that the source and dose of the PE used can have marked effects on the response of the animal. The objective of the experiments herein was to determine the effect of a PE additive (a microencapsulated, rumen-unprotected blend of cinnamaldehyde and eugenol) on the milk production performance of lactating dairy multi- and primiparous cows across a range of doses.

MATERIALS AND METHODS

Both experiments were conducted at the Purdue University Dairy Cattle Research and Education Center (West Lafayette, IN). The Purdue University Institutional Animal Care and Use Committee approved animal use procedures.

Experiment 1

Animals and Treatments. Thirty-two Holstein multi- and primiparous cows were selected from the Purdue University Dairy Cattle Research and Education Center, stratified by milk production within parity group (primi- vs. multiparous) and randomly assigned within group to 1 of 2 dietary treatments (n = 16 cows/treatment; each treatment group comprised 5 primiparous and 11 multiparous cows): control (no feed additive) or cinnamaldehyde-eugenol additive (**CE**; XT-6965, 17% cinnamaldehyde and 28% eugenol; Pancosma SA, Geneva, Switzerland) for a 6-wk period, which was preceded by a 1-wk covariate period during which all cows were fed the control diet. At the beginning of the trial cows were 112 ± 9 DIM with an average daily milk production of 39.7 ± 2.1 kg/d, an average lactation number 2.4 ± 0.3, and an average BW of 577 ± 16 kg.

Cows were housed in individual tie stalls and milked twice daily. One week before the beginning of data collection, all cows were transitioned to the control diets used during the following 6-wk experiment. Cows were offered a TMR once daily for ad libitum intake (5 to 10% refusals). Diets contained corn silage, legume haylage, triticale silage, grass and legume hay, roasted soybeans, soyhulls, high-moisture corn, and a protein-mineral-vitamin supplement (Table 1). Individual ration ingredients were sampled weekly and analyzed for DM content, and the data were used to adjust the as-fed ration ingredients. Diets were top-dressed with 0.23 kg of ground corn (control) or ground corn containing 350 mg of the CE additive.

Measurements. Milk production was measured daily at each milking and milk samples were collected weekly from 2 consecutive milkings beginning with the evening milking on d 2, 9, 16, 23, 30, and 37 relative to initiation of treatment to determine effects on milk composition. Evening and morning samples for each sampling day were analyzed separately for percentage milk protein, fat, lactose, SCC, and MUN by Dairy One Laboratories (Ithaca, NY). Daily milk component yields and composition was calculated from milk composition values for each milking sampled and corresponding milk yields for each sampling time. Feed refusals for each cow were weighed daily for calculation