J. Dairy Sci. 100:1–8
https://doi.org/10.3168/jds.2016-11893

Effects of cinnamaldehyde or monensin on performance of weaned Holstein dairy heifers

C. E. Chapman,*[1] H. Chester-Jones,† D. Ziegler,† J. A. Clapper,‡ and P. S. Erickson*[2]
*Department of Biological Sciences, University of New Hampshire, Durham, NH 03824
†University of Minnesota Southern Research and Outreach Center, Waseca, MN 56093
‡South Dakota State University, Brookings, SD 57007

ABSTRACT

The objective of this 70-d study was to determine the effects of the essential oil cinnamaldehyde compared with the ionophore monensin on performance of weaned Holstein dairy heifers. Eighty-four Holstein dairy heifers (91 ± 3.33 d of age; 109 ± 7.55 kg) were housed in a naturally ventilated curtain side-wall, straw-bedded barn in 12 pens with 7 heifers/pen (3.98 m^2/head). Heifers were randomly assigned to 1 of 4 treatments in a completely randomized design: (1) control (CON; carrier, 908 g of ground corn), (2) monensin sodium [MON; 1 mg/kg of body weight (BW) + carrier], (3) cinnamaldehyde (CIN1; 1 mg/kg of BW + carrier), or (4) cinnamaldehyde (CIN2; 2 mg/kg of BW + carrier). The treatments were hand-mixed into a 20% crude protein (CP) whole shelled corn and protein pellet mix fed at 2.21 kg/heifer daily. Heifers had access to free-choice hay and water daily. Initial BW and hip heights were taken at the start of the study and every other week thereafter until calves reached 23 wk of age. Blood samples were also taken on each weigh day to determine plasma urea nitrogen, glucose, and insulin-like growth factor-1 concentrations. Fecal samples were taken from the same 3 heifers/pen initially and then at d 28, 56, and 70 of the study for coccidia counts. Cinnamaldehyde had no performance effects on growth, hay intake, hip height, or blood metabolites compared with MON or CON. Average daily gains were 0.98, 0.99, 1.01, and 1.03 kg/d, and average hay intakes per pen were 17.08, 16.34, 18.11, and 17.60 kg/d for CON, MON, CIN1, and CIN2, respectively. Fecal samples by pens indicated the presence of viable coccidia, but the counts were low and not consistent across heifers within each pen. No benefits were associated with supplementing cinnamaldehyde or monensin into grain mixes for weaned heifers.

Key words: cinnamaldehyde, heifer, essential oil, monensin

INTRODUCTION

The second highest cost to dairy producers is raising replacement heifers because of high feeding expenses and extensive labor (Cady and Smith, 1996). Optimizing feeding programs of dairy calves is imperative for the sustainability and profitability of dairy operations. In the United States, heifers may be fed coccidiostats and ionophores to prevent disease and promote growth, and in 2006, at least half of dairies fed either antibiotics or ionophores to weaned heifers to prevent disease or promote growth (USDA, 2007). The ionophore monensin has a mode of action that specifically targets the *Eimeria* parasite (Chapman et al., 2010).

The use of antibiotic ionophores, such as lasalocid and monensin, have been very successful in reducing energy and protein losses in the rumen by increasing the VFA propionate, decreasing ammonia nitrogen (N) concentrations, as well as improving feed efficiency in livestock productions (Van Nevel and Demeyer, 1998; Calsamiglia et al., 2007; Benchaar et al., 2008). However, their use in animal feeds is facing reduced social acceptance because of the appearance of residues in livestock products and possible development of antibiotic-resistant bacteria that may pose a risk to human health (Van Nevel and Demeyer, 1998; Calsamiglia et al., 2007; Benchaar et al., 2008). Antibiotic growth promoters used in animal diets have been banned in the European Union since 2006. Therefore, researchers have been investigating alternative ways such as feeding essential oils to improve heifer health status and feed utilization, thereby increasing rate of gain and decreasing the overall cost of heifer rearing (Bento et al., 2013).

Essential oils have been studied since the beginning of the 20th century, and the most important activities

Received August 19, 2016.
Accepted November 10, 2016.
[1]Current address: Penn State Extension-Bradford County, Towanda, PA 18848.
[2]Corresponding author: peter.erickson@unh.edu

of these compounds are antiseptic and antimicrobial (Cowan, 1999; Burt, 2004). They are generally recognized as safe for human and animal consumption (FDA, 2004).

In the poultry industry, the use of essential oils has been extensively studied, and Hume et al. (2006) observed that in chickens challenged with *Eimeria* species, supplementation of a blend of essential oils (Crina; DSM Nutritional Products Inc., Parsippany, NJ) resulted in a decrease in microbial communities and the appearance of an anticoccidial effect. *Eimeria* species causes coccidiosis, which is still one of the most endemic enteric diseases in broiler production. A blend of essential oils appeared to be effective against *Eimeria* species in poultry, and it may also be effective against *Eimeria* in bovines as well (Hume et al., 2006). Cinnamaldehyde (C_9H_8O), is a natural chemical compound found in the bark of the cinnamon tree. It is the active component of cinnamon oil (*Cinnamonum cassia*), accounting for 75% of its composition (Calsamiglia et al., 2007). It is a phenylpropanoid with antimicrobial activity, and it has been studied in poultry for effects on microbial communities (Hume et al., 2006; Venkitanarayanan et al., 2013); feedlot cattle for feed efficiency effects (Yang et al., 2010; Vakili et al., 2013); and lactating dairy cows for effects on DMI and milk yield and components (Tassoul and Shaver, 2009; Tekippe et al., 2013; Wall et al., 2014). A study was conducted using a commercially available mixture of several essential oils (Rumaxol, Soda Feed Ingredients, Monaco) with dairy heifers of approximately the same age. No differences in ADG, hip height gain, or DMI were found among treatments (Golombeski et al., 2010). However, no data currently exist describing the effects that cinnamaldehyde supplementation has on feed intake, performance, or blood metabolites of dairy heifers.

The objective of this study was to determine the effects of the essential oil cinnamaldehyde compared with the ionophore monensin sodium on performance of weaned Holstein dairy heifers. The hypothesis of this study was that supplementing heifers with cinnamaldehyde would improve performance over nontreated heifers and have the same performance effects as monensin-fed dairy heifers.

MATERIALS AND METHODS

Animals, Diets, and Treatments

This experiment was reviewed and approved by the University of Minnesota Institutional Animal Care and Use Committee (protocol no. 1505-32595A). The study used 84 Holstein dairy heifers from 3 commercial dairy farms in Minnesota. Calves arrived at the dairy facility within 1 wk of birth. Heifers began the study and were housed at the Southern Research and Outreach Center Calf and Heifer Research Facility from 91 to 161 d of age (June 2015 to September 2015). Eighty-four approximately 13-wk-old Holstein heifers were housed in a naturally ventilated curtain sidewall, straw-bedded barn in 12 pens with 7 heifers/pen (3.98 m^2/head) for 70 d (3 pens per treatment). Bunk space was 0.522 m/heifer. Across treatments, pen age averaged 91.1 ± 3.33 d and BW averaged 109 ± 7.55 kg per heifer (mean ± SD).

Heifers were randomly assigned to 1 of 4 treatments in a completely randomized design: (1) control (**CON**; carrier, 908 g of ground corn), (2) monensin (**MON**; 1 mg/kg of BW + carrier), (3) cinnamaldehyde (**CIN1**; 1 mg/kg of BW + carrier), and (4) cinnamaldehyde (**CIN2**; 2 mg/kg of BW + carrier). These doses were based on the results of a sequential elimination taste preference experiment (Chapman et al., 2016). The dosage of the treatments was based on average pen BW and adjusted biweekly. The treatments were hand-mixed into a 20% CP whole shell corn and protein pellet mix. Heifers had access to free choice hay from the same bale and water daily. A commercial whole shelled corn and pellet concentrate mixture (Hubbard Feeds Inc., Mankato, MN) containing 20.5% CP (DM basis) was fed to heifers at 15.47 kg/pen (2.21 kg/head) daily. Cinnamaldehyde (≥95%, Sigma-Aldrich Corp., St. Louis, MO) and monensin pellet (2 g/454 g; Hubbard Feeds Inc.) were hand-mixed in the ground corn carrier and then hand-mixed into the whole shell corn and protein pellet mix at 0900 h daily (except on weigh days when feeding occurred immediately after measurements and blood samples were taken). After the concentrate mixture and treatments were consumed (within 30 min of feeding), free choice hay was given. Nutrient analyses

Table 1. Nutrient analysis of hay and whole shell corn and protein pellet mix (DM basis)

Item	Alfalfa/grass hay[1]	Concentrate mixture[2]	Monensin sodium pellet
DM, %	86.5	92.3	91.7
CP, %	18.0	20.5	17.9
Fat, %	1.54	4.49	3.69
ADF, %	31.6	6.82	15.1
NDF, %	43.4	9.25	32.5
Starch, %	—	43.8	23.1
Ash, %	10.6	6.23	8.64
Ca, %	1.80	1.12	6.42
P, %	0.31	0.67	0.69
Mg, %	0.32	0.32	0.36
K, %	2.90	1.02	0.91

[1]Hay fed ad libitum to all heifers.

[2]Concentrate mixture was offered up to 2.21 kg (DM basis per head per day).