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Short communication: Cinnamaldehyde taste preferences of weaned dairy heifers

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ABSTRACT

Within a dairy enterprise, one major cost is raising young calves. Optimizing the feeding programs of dairy calves is imperative for the sustainability and profitability of dairy operations. Essential oils appear to be natural alternatives to antibiotics and function similarly to ionophores. Supplemental antibiotic ionophores have been very successful in improving feed efficiency and rate of gain in calves, as well as decreasing disease incidences; however, calves may be developing resistance to ionophores and the use of antibiotics in animal feeds has been a major concern for consumers. No current research has examined the value or palatability of supplementing essential oils to dairy heifers. The purpose of this sequential elimination experiment was to evaluate the taste preferences of 6 weaned dairy heifers [approximately 3 mo old; 95 ± 10.8 kg of body weight (BW)] provided with 0 (control), 1, 2, 3, or 4 mg/kg of BW of cinnamaldehyde daily. Heifers had 2 d of adaptation to the new feeding regimen before the experiment started and were then offered the 5 experimental diets for 5 d. The most preferred diet was removed and the study continued with the 4 remaining diets. The most preferred diets were again eliminated sequentially, so that only 2 diets remained on d 13 and 14. Each diet was ranked based on the weight of feed refused at the end of each feeding segment. Overall ranking of the 5 treatments were control, 2, 1, 3, and 4 mg/kg of BW of cinnamaldehyde. Results indicated that heifers preferred diets without cinnamaldehyde; however, when only cinnamaldehyde diets remained, dry matter intake was not negatively affected regardless of the concentration of cinnamaldehyde provided.

Key words: heifer, essential oil, cinnamaldehyde, taste preference

Short Communication

Essential oils are gaining interest because the use of antibiotics in animal feeds is facing reduced social acceptance due to the appearance of residues and possible development of antibiotic-resistant bacteria that may pose a risk to human health. The use of antibiotic ionophores, such as lasalocid and monensin, has been very successful in reducing energy and protein losses in the rumen by increasing propionate, decreasing ammonia nitrogen concentrations, and improving feed efficiency in livestock productions (Van Nevel and Demeyer, 1998; Calsamiglia et al., 2007; Benchaar et al., 2008). However, researchers have recently investigated feeding essential oils as an alternative way to achieve the same outcomes as antibiotics to improve heifer health status and feed utilization, thereby increasing rate of gain and decreasing the overall cost of heifer rearing (Calsamiglia et al., 2007; Benchaar et al., 2008).

Essential oils have been studied since the beginning of the 20th century and the most important activities of these compounds are antiseptic and antimicrobial (Cowan, 1999; Burt, 2004). They are considered safe for human and animal consumption (generally recognized as safe, GRAS; US FDA, 2004). 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 has been studied in poultry and feedlot cattle to determine its effects on disease and feed efficiency (Hume et al., 2006; Calsamiglia et al., 2007; Venkitanarayanan et al., 2013). No data currently exist that describe the palatability effects of cinnamaldehyde supplementation on feed intake or performance of dairy heifers. Therefore, the objective of this study was to determine the short-term taste preference of cinnamaldehyde at 5 doses (0, 1, 2, 3, or 4 mg/kg of BW) to weaned dairy heifers exposed to this compound for the first time, using the sequential elimination procedure of Nombekela et al. (1994). The outcome would then determine which doses

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are tolerable for future studies with cinnamaldehyde and dairy heifers.

This experiment was reviewed and approved by the University of New Hampshire Institutional Animal Care and Use Committee (Protocol #150103). Six Holstein heifers, approximately 3 mo old (95 ± 10.8 kg of BW) were used to test the preference of control (no cinnamaldehyde), and 1, 2, 3, or 4 mg/kg of BW of cinnamaldehyde (≥95%; Sigma-Aldrich Corp., St. Louis, MO). The treatments were chosen based on the amounts of monensin fed to control to prevent coccidiosis. The cinnamaldehyde treatment was added to 20 g of corn meal carrier, and heifers were fed the experimental TMR (Table 1) at 1000 h daily. Before the experiment started, the heifers were fed a different diet to decrease any potential bias. It consisted of 50% corn silage, 12.5% haylage, 18% protein mix, 17.5% energy mix, and 2% vitamin and mineral mix, with 17.3% CP, 20.5% starch, 24.1% ADF, and 40% NDF. Components of the protein mix, energy mix, and vitamin and mineral mix were the same as used in the experiment (Table 1). During the experiment, forage and concentrate proportions were different from those before the start of the study. Feed was mixed and delivered using a mobile feed cart (Data Ranger; American Calan Inc., Northwood, NH). Treatments were top-dressed and hand-mixed into each individual feed tub. The pen, experiment setup, and animal number reasoning were similar to that described by Nombekela et al. (1994) and Erickson et al. (2004, 2012). In those studies, 6 animals were used to determine taste preferences. During the experiment, heifers were individually housed in 1 of 2 calf hutches (CalfTel, Germantown, WI) measuring 2.7 × 2.2 × 1.9 m with an attached pen measuring 2.7 × 3.1 m. Each hutch was bedded with kiln-dried sawdust and water was available for ad libitum consumption. A manger measuring 69 cm wide × 395 cm long × 61 cm high was placed on one side of the pen, adjacent to the water supply. The manger contained 5 containers, each measuring 27 cm deep × 42 cm wide × 47 cm long. The containers were positioned randomly at each feeding within the manger except that those on each end were left empty. The same amount of feed was added to each container and calculated to provide 10% orts for every diet. Feed offered and orts were weighed and recorded daily. Each container held an adequate amount of feed to accommodate a heifer consuming feed from only 1 bin. The experimental period lasted from d 1 to 14. There were 3 experimental periods with 2 heifers being tested simultaneously. Each heifer was housed and fed individually. Heifers had 2 d of adaptation to the new feeding regimen before the experiment started and were then offered the 5 experimental diets for 5 d. The most preferred diet was removed and the study continued with the 4 remaining diets. The most preferred diet was then eliminated sequentially, so that only 2 diets remained on d 13 and 14. Therefore, at the end of each feeding segment (d 5, 9, 12, 14), the most preferred diet was eliminated sequentially. The empty tubs were placed on either end of the manger. The ranking of the last 2 treatment diets was determined at the end of the study. Therefore, 5 treatments were offered for 5 d, 4 treatments for 4 d, 3 treatments for 3 d, and 2 treatments for 2 d. Treatments were removed to allow the ranking of the first, second, third, and fourth preferred tastes.

Table 1. Ingredient composition (DM %) of the experimental diet

Item	Value
Corn silage	57.21
Grass haylage	22.39
Canola meal	2.61
Soybean meal	8.26
Distillers grain	0.87
Urea	0.21
Soybean hulls	0.79
Corn meal	2.56
Molasses	0.28
Steam-flaked corn	0.98
Beet pulp	1.87
Vitamin and mineral mix[1]	1.99

[1]Contained 19% Ca, 6% P, 3.5% Mg, 1.5% K, 2% S, 7.8% Na, 12.2% Cl, 25 mg/kg of Se, 0.26% Zn, 0.29% Fe, 0.26% Mn, 1,196 mg/kg of Cu, 15 mg/kg of I, 55,089 IU/kg of vitamin A, 22,848 IU/kg of vitamin D, and 454 IU/kg of vitamin E.

Samples of the TMR and orts were collected daily for determination of DMI. Samples were dried in a forced hot-air convection oven at 55°C for 48 h (Binder, Bohemia, NY). Samples of TMR were pooled over the 14-d feeding period. The composited samples were then ground through a 1-mm screen using a Wiley mill (Thomas Scientific; Swedesboro, NJ). Samples were sent to Analab (Fulton, IL) for analysis of ADF (method 973.18), NDF (method 2002.04), CP (method 990.03), starch (enzymatic method using glucose Trinder method), crude fat (method 920.39), ash (method 942.05), Ca, P, Mg, and K (method 98.01), and S (method 923.01) according to AOAC International methods (AOAC International, 1999; Table 2).

Heifers were weighed on a platform scale (A and A Scales LLC, Prospect Park, NJ) before the experiment started to determine the quantity of cinnamaldehyde (0, 1, 2, 3, or 4 mg/kg of BW) per diet.

Taste preferences were analyzed by ranking the consumption of the diets from most to least preferred. Rankings were determined by giving a 1 to the diet the heifer preferred the most (consumed the most DMI during the first 5-d period when all treatments were given) up to a 5 for the diet the heifer preferred the least. The rankings were summed and then divided by