Animal Feed Science and Technology 234 (2017) 274–283

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Essential oils in the diet of young bulls: Effect on animal performance, digestibility, temperament, feeding behaviour and carcass characteristics

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ARTICLE INFO

Keywords:
Cinnamaldehyde
Cinnamon
Clove
Eugenol
Feedlot

ABSTRACT

With the increase of public concern over the routine use of antibiotics in livestock, the addition of plant extracts and essential oils (EOs) became a natural alternative in the diets since it might have similar antimicrobial properties as the ionophores. This study was conducted to evaluate the animal performance, temperament, feeding behaviour and carcass characteristics of 40 young crossbred bulls (½ Brown Swiss – ½ Nellore) at 10 ± 2.2 months of age with an average body weight of 219 ± 11.7 kg without (control) the addition or with different levels (3.5 or 7.0 g/day per animal) of clove or cinnamon EOs in the diet. The finishing period in the feedlot was 187 days. Animal performance was higher ($P < 0.05$) in the group with EOs (both levels) than in the control group diet and increased linearly when EOs was added ($P \leq 0.05$). The feed intake of dry matter and other nutrients was higher and increase linearly ($P < 0.05$) in young bulls fed with EOs independently of the type or dosage level. Feed efficiency and the digestibility *in vitro* were unaffected by dietary treatment ($P > 0.05$). The addition of clove or cinnamon EOs did not alter ($P > 0.05$) temperament or feeding behaviour. The cold carcass weight was higher ($P < 0.05$) in bulls from the EOs groups than in the control group. However, the carcass weight was similar ($P > 0.05$) between young bulls with EOs received clove or cinnamon in the diet. The muscle, fat and bone percentages and fat thickness, marbling, *Longissimus* muscle area and pH did not differ ($P > 0.05$) among diets. The results indicate that the EOs improved the animal performance of young bulls finished in high-concentrate diets did not alter carcass characteristics, temperament or feeding behaviour.

1. Introduction

Antibiotics are commonly used in the diets of animals in some countries to prevent diseases and metabolic disorders and to

Abbreviations: EOs, essential oils; BW, body weight; FBW, final body weight; OM, organic matter; DM, dry matter; DMI, dry matter intake; NDF, neutral detergent fiber; ADF, acid detergent fiber; CP, crude protein; DMD, digestibility of the dry matter; CCD, cold carcass dressing; CCW, cold carcass weight; LM, *Longissimus* muscle; GLM, general linear model; ADG, average daily gain; ORAC, Oxygen Radical Absorbance Capacity; SEM, standard error mean; ANOVA, analysis of variance

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http://dx.doi.org/10.1016/j.anifeedsci.2017.10.008
Received 22 June 2017; Received in revised form 18 October 2017; Accepted 21 October 2017

improve feed efficiency. These additives improve rumen digestion by changing the rumen fermentation; thus, the energy losses by methane gas production are reduced, and the acetate:propionate ratio is improved (Russell and Strobel, 1989). However, public concern over the routine use of antibiotics in livestock has increased due to the emergence of antibiotic-resistant bacteria that could represent risks to human health (Russell and Houlihan, 2003). Due to the growing tendency of the addition of growth promoters, such as antibiotics, in 2006 the European Union banned the use of those products on the basis of the precautionary principle that the bacteria would evolve resistance and cause problems for human health.

Consequently, considerable efforts have been employed towards the development of alternative products to antibiotics. Plant extracts and essential oils (EOs) offer an opportunity in this regard (Zhang et al., 2010; Jayasena and Jo, 2013; Cruz et al., 2014; Rivaroli et al., 2016) because several plants produce secondary metabolites with antimicrobial properties (Kouazounde et al., 2016).

EOs are considered potential natural substitutes of antibiotics, improving the performance, the feed efficiency and preventing future health damage to consumers, derived from the antibiotics residues. Therefore, they are an alternative for optimizing beef cattle production systems. The use and effects of EOs and their components on ruminal fermentation *in vitro* have been previously studied by others researchers (Chaves et al., 2008, 2011). However, beef cattle performance *in vivo* has scarcely been studied in relation to *in vitro* research.

The EOs (clove and cinnamon) were select according to previous study (Biondo et al., 2017) that demonstrated its higher antioxidant power. In addition, clove and cinnamon EOs had also showed antimicrobial activity, affecting the ruminal microorganisms (Chaves et al., 2008; Patra and Yu, 2012; Patra, 2011).

The main compounds present in clove essential oil (*Eugenia caryophyllus*) are eugenol, carophylenne and acetate of eugenila, and in cinnamon essential oil (*Cinnamon zeylanicum*) are cinnamaldehyde, benzaldeide, cinamic alcohol and cumarina (Biondo et al., 2017). Eugenol and cinnamaldehyde have a great ability to modify the microbial fermentation in the rumen and may improve nutrient utilization in ruminants. These properties are similar in both compounds due to the presence of chemical compounds from the same class (Phenylpropanoides) (Benchaar et al., 2008; Hristov et al., 2008; Geraci et al., 2012). These are some of the most important compounds widely used in human medicine with a potent antioxidant, antibacterial and fungicidal power (Hart et al., 2008).

Volatile and odorant compounds from EOs have a potential addition as feed additives in animal nutrition due to palatably properties (Franz et al., 2010), but they also have an activity in the temperament of animals, working in the nostrils by sending signals to the central nervous system and releasing endorphins that affect the feeling of animal welfare (Broughan, 2002). Little research in relation to animal temperament fed with essential oil has been done. Thus, this study was conducted to evaluate the animal performance, temperament, ingestion behaviour and carcass characteristics of young bulls finished in a feedlot fed with high-grain diets and with addition of EOs from clove and cinnamon as an additive.

2. Materials and methods

2.1. Animals, diets, ethic committee and local

This experiment was approved by the Department of Animal Production and Research Ethic Committee at the State University of Maringá, and it followed the guiding principles of biomedical research with animals n° 081/2014. The study was conducted at the Rosa & Pedro Sector, State University of Maringá, Experimental Farm Station at Iguatemi city, Paraná, southern Brazil. A total of 40 (½ Brown Swiss – ½Nellore) young bulls (half-brothers) at10 ± 2.2 months of age and with a body weight (BW) of 219 ± 11.7 kg were used in a completely randomized design. The bulls were weighed at the beginning of the experiment and assigned to 10 m^2 individual pens, partially covered and with concrete floors.

The bulls were distributed into five treatments according to initial BW. The adaptation period before starting the experiment lasted two weeks, when the concentrate was supplied gradually. The bulls were weighed every 28 days at the trunk balance (Beckehauser Cia. Paranavaí city, Paraná, south Brazil).

The basal diet comprised 900 g/kg concentrate and 100 g/kg cane sugar pellets, and it was offered *ad libitum* for 187 days. The feed intake was recorded daily. The basal diet was the same for all animals, formulated to be isonitrogenous and isoenergetics (Table 1) according to NRC (2000). The five experimental diets were as follows: CON – without essential oil, CLO35–inclusion of 3.5 g of essential oil of clove leaf per animal and day (370, 58, and 5.69 mg/kg of dry matter/animal per day of eugenol, carophylenne and eugenyl acetate, respectively), CLO70–inclusion of 7.0 g of essential oil of clove leaf per animal and day (740, 116, and 11.38 mg/kg of dry matter/animal per day of eugenol, carophylenne and eugenyl acetate, respectively), CIN35–inclusion of 3.5 g of essential oil of cinnamon leaf per animal and day (350, 21, and 14.35 mg/kg of dry matter/animal per day of cinnamaldehyde, carophylenne and α-pinene, respectively), and CIN70–inclusion of 7.0 g of essential oil of cinnamon leaf per animal and day (700, 42, and 28.7 mg/kg of dry matter/animal per day of cinnamaldehyde, carophylenne and α-pinene, respectively), the inclusion of EOs was made every 15 days, adjusting the inclusion according to the intake of dry matter/day per animal, to maintain a constant dosage per animal/day.

The clove essential oil contained 845 g/kg, 133 g/kg and 13 g/kg of eugenol, carophylenne and eugenyl acetate, respectively, and cinnamon essential oil contained 788 g/kg, 47 g/kg and 32 g/kg of cynnamaldheyde, carophylenne and α-pinene, respectively, was determined by Biondo et al. (2017). The EOs were obtained from FERQUIMA® (Vargem Grande Paulista, São Paulo, Brazil) and stored at 4 °C. They had a liquid texture and were mixed with the concentrate in a commercial mixer every two weeks, when the diets were prepared. Hence, the inclusion of EOs was made every 15 days, adjusting the inclusion according to the intake of dry matter/day per animal, to maintain a constant dosage per animal/day.