Livestock Science 185 (2016) 117–122

Contents lists available at ScienceDirect

Livestock Science

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

Effect of essential oils and distillation residues blends on growth performance and blood metabolites of Holstein calves weaned gradually or abruptly

Maryam Jeshari [a], Ahmad Riasi [a,*], Amir Hossein Mahdavi [a], Mohammad Khorvash [a], Farhad Ahmadi [b]

[a] Department of Animal Science, College of Agriculture, Isfahan University of Technology, Isfahan 84156-83111, Iran
[b] Golpooneh Safahan Co., Isfahan Science & Technology Town (ISTT), Isfahan, Iran

ARTICLE INFO

Article history:
Received 12 April 2015
Received in revised form
27 December 2015
Accepted 28 December 2015

Keywords:
Essential oil
Distillation residue
Weaning
Blood metabolites
Performance
Calves

ABSTRACT

The objective of this study was to investigate preweaning calf performance responses and initial post-weaning profile of some blood metabolites to dietary supplementation of calf starter with essential oils or distillated residues blend (*Rosmarinus officinalis* L., *Zataria multiflora* Boiss, and *Mentha pulegium* L.). Sixty Holstein calves, were randomly assigned to three dietary treatment groups: (1) starter with no additive (CON), (2) starter with essential oils blend (EOB, 300 mg/kg starter), and (3) starter with distillation residues blend (DRB, 50 g/kg starter). The blend was prepared by mixing the essential oils or the distillation residues (1:1:1) and then was added to the starter diet. Each group of calves was weaned based on two different methods: (1) gradual weaning during 4 d [G], and (2) abrupt weaning [A]. Results of DPPH test showed that radical scavenging activity of EOB was higher than DRB (81.4 vs. 15.4%) ($P < 0.05$). Supplementation of the starter diets with essential oils and/or distillation residues increased ($P < 0.05$) feed intake and average daily weight gain of calves. These calves had about 3 d lower age ($P < 0.05$) and higher body weight (BW) at the weaning time. Calves fed EOB had higher ($P < 0.05$) insulin concentrations during the weaning period, especially in abrupt weaned group compared to the group CON-A. The weaning method and treatment had no effect on total serum protein (TSP), serum albumin and globulin. It is concluded that supplementation of starter diets with a mixture of essential oils or distillation residues had a beneficial effect on the growing performance of suckling calves and may change some of blood metabolites.

1. Introduction

The future profitability and sustainability of a dairy farm is largely determined by how effective its calf-feeding system is (Khan et al., 2007). Efficient management and feeding system contribute significantly to calf growth, health, and productivity (Tahmasbi et al., 2014). Using of antibiotics as promoters of growth has widely been prohibited in animal nutrition, because antibiotic resistance has become a major clinical and public health problem (Benchaar et al., 2008). Hence, during the last decades, the use of alternative feed additives in animal production has been considered. Among these, the herbal essential oils and distillation residues which contain natural antioxidants have been the subject of several researches (Benchaar et al., 2008; Nieto et al., 2011).

The beneficial effects of plant-derived essential oils bearing antioxidant activity on ruminal metabolism to improve feed efficiency and animal productivity, have been confirmed in many studies (Benchaar et al., 2008). *Rosmarinus officinalis* L. is a perennial herb which is native to the Mediterranean region, and cultivated throughout the world as an aromatic and ornamental plant (Ra et al., 2014). Rosemary contains a wide variety of compounds such as α-pinene, β-pinene, 1, 8-cineole, and camphor which are derived from its secondary metabolism (Benchaar et al., 2008; Brenes and Roura, 2010), and its essential oil or leaf distillate has successfully been used as an animal feed additive (Nieto et al., 2011). Chiofalo et al. (2012) reported that dietary supplementation of dairy ewes with rosemary extract increased their milk yield and attenuated the stress associated with lactation. *Zataria multiflora* Boiss is a native Iranian herbal plant, known as Avishan-e-Shirazi. The components of its essential oil are thymol, carvacrol, p-cymene, γ-terpinene and β-caryophyllene, together conferring it

* Corresponding author.
E-mail address: ariasi@cc.iut.ac.ir (A. Riasi).

http://dx.doi.org/10.1016/j.livsci.2015.12.011
1871-1413/

potent antioxidant activity as well as inhibitory effects against some pathogenic bacteria and fungi (Sharififar et al., 2007; Mansour et al., 2010; Talebzadeh et al., 2012). *Mentha pulegium* L. as an aromatic plant has strong antimicrobial and antioxidant activity. The essential oils of these plants are mainly piperitone, piperitenone, α-terpineol, and pulegone (Mahboubi and Haghi, 2008).

In the present study, it was hypothesized that a mixture of natural antioxidants added to a calf starter diet would improve the growth performance and attenuate the stress associated with weaning methods. Despite the large number of studies on supplementation of essential oils in diets of poultry (Brenes and Roura, 2010) and dairy cows (Benchaar et al., 2006; Kung et al., 2008), very limited data are available related to the effects of plant-derived natural antioxidants on calves performance. Therefore, this experiment was conducted to compare the effect of dietary supplementation of calf starter with either blend of essential oils or distillation residues of three herbal plants on growth performance and some blood metabolites of Holstein calves weaned gradually or abruptly.

2. Materials and methods

2.1. Herbal essential oils and distillation residues and the 1, 1-diphenyl-2-picrylhydrazyl (DPPH) test

The essential oils and the distillation residues of three herbal plants (*R. officinalis* L., *Z. multiflora* Boiss, and *M. pulegium* L.) were provided by Research Center of Barij Essence Pharmaceutical Co. (Kashan, Iran). At first, all distillation residues of plants were extracted by hydrodistilation using the clevenger apparatus (Taheri Gandomani et al., 2014). Then the antioxidant activity of each plant essential oil and the extraction of distillation residue, and the mixture of essential oils (1:1:1) and residue extracts (1:1:1) were determined based on the radical scavenging ability on DPPH. Changes in the absorbance of the samples were measured at 517 nm (6505 UV/vis Spectrophotometer, Jenway). The DPPH radical-scavenging potential of each plant was evaluated in terms of percent reduction of the initial DPPH absorption (Brand-Williams et al., 1995). Butylated hyroxytoluene (BHT) was used as a synthetic antioxidant control.

2.2. Experimental protocols, diets, and chemical analyses

The experiment was conducted from October 2013 to March 2014 on a commercial dairy farm (Goldasht-e-Sepahan, Isfahan, Iran). The Animal Care Advisory Committee of the Isfahan University of Technology approved all experimental procedures. The experiment was conducted according to the Iranian Council of Animal Care guidelines (1995).

Sixty newborn Holstein calves (30 male and 30 female calves, 40.3 ± 5.1 kg BW) were kept in individual wood shavings-bedded pens (1.2×3 m^2) with concrete floor. Calves received colostrum from their dams during the first 3 d of age and then fed whole milk (divided into two equal portions at 0600 and 1800 h, using calf buckets, 3 kg of fresh milk/head/day from d 4 to 15, 5 kg from d 16 to 45, and 4 kg from d 46 until weaning). Each group of calves was weaned gradually (4 d period) or abruptly (1 d period).

Calves had free access to starter diet and fresh water all times during the trial. The starter diet was formulated based on NRC (2001) recommendations and the nutrient composition is presented in Table 1. Holstein calves were randomly assigned to three dietary treatment groups: (1) starter with no additive (CON), (2) starter with essential oils blend (EOB, 300 mg/kg starter), and (3) starter with distillation residues blend (DRB, 50 g/kg starter). The groups were filled randomly and gradually (during a 25 d period). All groups had access to chopped alfalfa hay (10% of starter diet) ad libitum and in the third group, a part of alfalfa hay was replaced with distillation residues blend as the final residues was 50 g/kg starter. The EOB diet was prepared daily throughout the experimental period to avoid the evaporation of volatile essential oils (Westendarp, 2005).

Table 1
Feed ingredients and chemical composition of the calf starter.

Item	g/kg of DM
Ingredients	
Corn grain, ground	450
Soybean meal	200
Barley grain, ground	100
Corn gluten	50
Wheat germ meal	50
Wheat bran	100
Calcium carbonate	10
Dicalcium phosphate	10
Common salt (NaCl)	5
Manganese oxide	3
Sodium bentonite[a]	5
Mycofix	2
Vitamins and Minerals[b]	15
Composition	
Dry matter	920
Crude protein	212
Ether extract	32
Calcium[c]	8.2
Available phosphorous[c]	7.3
ME, Mcal/kg[c]	2.58

[a] ZarinBinder®, Zarinkhak Ghaen Co., Mashhad, Iran.
[b] Contained per 1 kg of supplement: 200,000 IU of vitamin A, 50,000 IU of vitamin D, 1500 IU of vitamin E, 10 mg of Se, 1.25 g of Cu, 1.25 g of Fe, 20.5 g of Mg, 3 g of S, 14 mg of Co, 2.20 g of Mn, 7.7 g of Zn.
[c] Calculated (NRC, 2001).

Starter intake and average daily gain (ADG) were monitored weekly from d 8 to 56 of experiment. At d 7, the average weight of calves in CON, EOB and DRB groups was 40.6, 40.7, 40.6 kg, respectively. Feces samples were scored for determination of consistency based on a five-point scale (Heinrichs et al., 2003). Upon consuming 1 kg starter feed for 3 consecutive days, each group of calves was weaned based on two different methods: (1) gradual weaning during 4 d [G] and (2) abrupt weaning [A]. So, after weaning there were six experimental groups: (1) CON-G, (2) EOB-G, (3) DRB-G, (4) CON-A, (5) EOB-A, and (6) DRB-A.

The starter diet was analyzed for dry matter (oven drying at 60 °C, 48 h), ether extract (AOAC, 1990, Tecator Soxtec System HT 1043 extraction unit by Tecator, Foss North America, Eden Prairie, MN), and crude protein (1030 micro-Kjeldahl auto analyzer; Tecator, Foss North America).

2.3. Blood sampling and analysis

Blood was sampled once daily before morning feeding during the 4 d after weaning start. Blood samples were collected from the jugular vein of all calves into 10-ml vacuum tubes. Then the tubes were placed on ice and centrifuged at 3000 rpm for 15 min at 4 °C. Serum samples were preserved at −20 °C until future analysis. Serum concentration of insulin was measured using radio immunoassay (RIA) method with a commercial kit (Pars Azmoon Kits; Pars Azmoon, Tehran, Iran) and an automatic gamma-counter (Biosource International Inc., Camarillo, CA). Serum concentrations of glucose, total serum protein, albumin, aspartate aminotransferase (AST), triglycerides, and cholesterol were determined using commercial Kits (Pars Azmoon Kits; Pars Azmoon, Tehran, Iran) by an automated analyzer (Technicon-RA 1000 Auto