Biological Forum – An International Journal **7**(1): 1173-1177(2015)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effects of Specific Essential Oil Compounds on Feed Intake, Blood Metabolites and Body Condition Score in Early Lactating Dairy Cows

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(Received 02 March, 2015, Accepted 17 April, 2015)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT. The objective of this study was to determine effect of dietary essential oil (EO) compounds, which contained cinnamaldehyde, eugenol, peppermint, coriander, cumin, lemongrass, and an organic carrier on feed intake, blood metabolites, and body condition score (BCS). Forty Holstein cows were assigned to one of two treatment groups: a Control and EO fed. The experiment lasted 50 days. Dry matter intake (DMI) was measured daily while blood metabolites and BCS were measured at d 30 and 50 of the experiment. In conclusion, our result showed that supplementation with EO mixture increased DMI and improved energy status as evidenced by lower BCS loss and improved some blood metabolic profiles at early lactation.

Keywords: dairy cow, feed additive, plant extract.

INTRODUCTION

Essential oils (EO) are bioactive plant compounds found in many plants that considered as possible alternatives to feed antibiotics in animal production (Wallace, 2004). Recently, there have been several investigations have studied the influence of various EO on production performance in lactating dairy cattle (Santos *et al.,* 2010; Tekippe *et al.,* 2013; Wall *et al.,* 2014). Calsamiglia *et al.* (2007) noted that plant extracts cinnamaldehyde, eugenol, and capsicum have antimicrobial properties and may modify the rumen environment. A number of studies have been reported the effect of EO on milk production in dairy cattle is not consistent, ranging from -6.7 to + 5% differences from control (Kung *et al.,* 2008; Patra, 2011). Feeding a blend of EO (thymol, eugenol, vanillin, guaiacol, and limonene) at a moderate dose (600 mg/d) increased DMI of lactating dairy cows (Benchaar *et al.,* 2007). Spanghero *et al.* (2009) reported that a blend of eugenol, and cinnamaldehyde fed at moderate doses (~500 mg/d) had no effect on DMI or milk production. The effects of EO on DMI are not actually consistent depending on the number of factors such as EO source, type of diet, diet interactions or adaptation of rumen microbial populations to EO (Yang *et al.,* 2010; Geraci *et al.,* 2012).

Effects of EO on blood metabolites in dairy cows have not been investigated widely. Devant *et al.* (2007) reported that EO supplementation did not significantly affect blood glucose concentration of dairy cows. Yang *et al.* (2010) reported that concentrations of some blood metabolites such as triglycerides can be influenced by EO supplementation via changing of feed intake.

Therefore, this project was designed to determine how feeding EO (BioHerbal®) to early lactation dairy cows affects intake, and blood metabolites. The aim of this work was to investigate the effects of an EO blend additive on feed intake, blood metabolites, and BCS in dairy cows. The effects of the dietary supplementation of EO on BCS were also investigated.

MATERIALS AND METHODS

A. Experimental location and animal care

The experiment was conducted at was conducted at the Natural Resources & Agricultural research farm of the Tehran University Karaj, Iran according to the guidelines of the Iranian Council of Animal Care (Anonymous, 1995).

Animals and treatments. A specific blend (BioHerbal®) of EO compounds manufactured by Pars-Imen-Daru Herbal Medicines Development Co., (Tehran, Iran) was used in this experiment.

BioHerbal® was a defined and patented blend of natural and natural-identical EO compounds that included peppermint, coriander, cumin, lemongrass, and an organic carrier. Forty multiparous Holstein cows were randomly assigned to either control or EO-supplemented (2 g/cow per day) total mixed rations (TMR). At the beginning of the trial cows were 15 ± 2 DIM with an average daily milk production of 41.5 ± 1.3 kg/d, and an average BW of 610 ± 12 kg. The TMR contained 40% forage and 60% concentrate; DM basis. The experimental period lasted for 50 days.

Cows were individually fed a TMR that include either the control or EO premix once daily in tie stalls for ad libitum intake (5 to 10% refusals). BioHerbal® was premixed with a concentrate and mixed with a portion of the TMR before feeding.

Sampling and measurements. The TMR amounts fed and refused were recorded daily. Metabolite analyses were performed on blood samples collected at day 30, and 50 after parturition. Blood was withdrawn from the jugular vein into vacutainer tubes (Becton, Dickson and Co., Franklin Lakes, NJ) containing lithium heparin and immediately put on ice. Tubes were immediately placed on ice and centrifuged at 3000 × g at 0°C for 20 min within 2 h of sampling. The plasma were separated and frozen at -20°C for subsequent analysis. Blood metabolite concentrations were determined by an automated biochemical analyzer (Technicon RA 1000; Bayer, NY, USA) using commercial kits (glucose (1-500-017), albumin (1-500-001), total protein (1-500-028), cholesterol (1-500-010), triglyceride (1-500-032); Pars Azmoon kits, Pars Azmoon Co., Tehran, Iran), and (β-hydroxybutyrate; DRG Co., Marburg, Germany) according to the manufacturer's instructions.

B. Statistical Analyses

All data from were analyzed using the PROC MIXED procedure of SAS software version 9.1 (SAS, 2002), with the animal as the experimental unit according to the following model:

$$Y_{ij} = \mu + T_i + \varepsilon_{ij}$$

where y_{ij} = dependent variable; μ = overall mean of the population; T_i = treatment, and ε_{ij} = unexplained residual element assumed to be independent and normally distributed. When differences ($P<0.05$) due to interactions or dietary treatments were detected, means separation was conducted using a Tukey adjustment for the probability. Significance was declared at $P<0.05$ and trends were considered at $0.05<P<0.10$.

RESULTS AND DISCUSSION

The effects of supplementation of dairy cows with EO (2 g/d) on DMI and blood metabolites variables are presented in Table 1. No differences in DMI occurred among treatments.

Table 1: Effect of supplemental dietary essential oils on least squares means for DMI, and blood metabolites of dairy cows.

Item	Control	EO mixture	SEM	*P*-value
DMI, kg	25.7	26.1	0.44	0.42
Glucose, mg/dl	64.5	63.3	0.97	0.36
Cholesterol, mmol/l	2.82[b]	3.00[a]	0.06	0.01
BHBA, mmol/l	0.76[a]	0.66[b]	0.04	0.05
Total Protein, g/l	81.9[b]	83.8[a]	0.09	0.01
Albumin, g/l	34.3	33.6	0.91	0.35
Globulin, g/l	47.7[b]	50.2[a]	0.94	0.01
Albumin: Globulin	0.72[a]	0.67[b]	0.02	0.01

[1]Total mixed rations supplemented with a specific mixture of plant essential oils (BioHerbal®, Pars-Imen-Daru Herbal Medicines Development Co., Tehran, Iran) targeted for 2 g/cow per day of premix (EO) or a control without the essential oils mixture.
[a,b] Within treatments, means with different superscript letters are different ($P<0.05$).

Various responses to EO supplements on DMI of dairy cows have been reported, such as a decrease (Fandi˜no *et al.,* 2008), increase (Cardozo *et al.,* 2004), or no effect (Benchaar *et al.,* 2007; Yang *et al.,* 2010; Tassoul and Shaver, 2009), which may be attributed to differences in dose, duration and processing of the medicinal plants, EO and/or to the different husbandry conditions (Giannenas *et al.,* 2011). Shaver and Tassoul (2008) summarized that feeding a mixture of natural and synthesized EO, including thymol, eugenol, vanillin, guaiacol, and limonene, may increase DMI and feed efficiency of dairy cows.

Daily DMI data for 30 days of experiment are presented in Fig. 1, which shows that EO cows fed greater ($P<0.01$) DMI during week 3 to 4 of lactation compared with control cows. A possible explanation for increase in DMI with EO supplementation could be that EO positively influenced the palatability of the TMR fed in this study.

The EO treatment had no effect (P>0.05) on blood glucose, and albumin concentration. Many previous researches have confirmed that there is no effect of EO supplementation on blood glucose concentration (Yang *et al.,* 2010; Devant *et al.,* 2007; Tassoul and Shaver, 2009; Chaves *et al.,* 2008).

In fact, most of dairy cows experience a negative energy balance (EB) which is considered as a main triggering factor of peripartum health problems (Hayirli *et al.,* 2011). Greater feed intake in early lactation in cows supplemented with EO may alleviate negative EB and lower body fat mobilization, which is in agreement with higher BCS in these cows. Lower plasma BHBA concentration also indicates improved energy status in cows received EO (BioHerbal®).

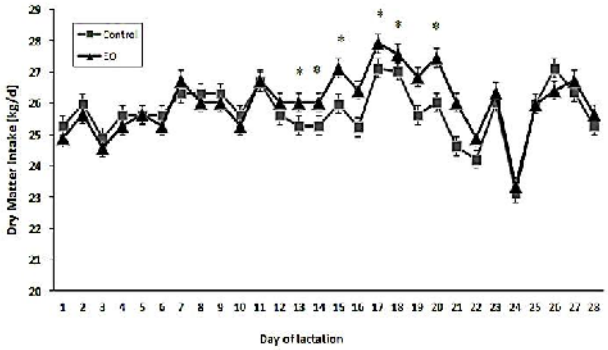

Fig. 1. Daily DMI least squares means for cows fed control (■) and essential oil (♦)-supplemented TMR. $^{**}P<0.05$.

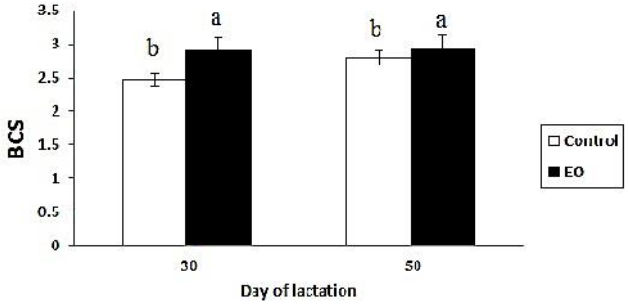

Fig. 2. Weekly BCS least squares means for cows fed control (♦) and essential oil (■)-supplemented TMR. $^{**}P< 0.01$.

The concentration of blood total protein, cholesterol, globulin concentrations, and albumin: globulin ratio was decreased (P<0.01) by EO compared with the control, although we identified a lower greater (P<0.01) blood BHBA content in EO cows. The previous studies related to the effects of diet containing EO or blend on blood parameters in dairy cows are limit. Sahraei *et al.* (2014) reported that supplementation with EO (400 mg d^{-1} of rosemary) had no effect on plasma concentrations of glucose, triglyceride, cholesterol, total protein and albumin in sheep.

Interestingly, the results of the present experiment suggest improved hepatic nutrient metabolism in cows supplemented with EO (BioHerbal®), which is evidenced by higher plasma cholesterol concentration. It is known that blood cholesterol in ruminants derives mainly from endogenous synthesis mostly in the hepatic tissue, whereby acetate and glucose serve as the major precursors to the de novo synthesis of cholesterol in ruminants (Liepa *et al.,* 1978). Because plasma glucose was the same between treatments, we speculate that other mechanisms related to clearance of cholesterol from circulation might be involved in the changes of plasma cholesterol in our study. Because the clearance of plasma cholesterol is enhanced during inflammatory states (Zebeli *et al.,* 2011), a greater cholesterol concentration in cows fed EO (BioHerbal®) could be therefore attributed to anti-inflammatory role of herbal bioactive compounds which might have led to a lower clearance of cholesterol. Likewise, Hosoda et al. (2006) reported that feeding clove bud at 5% of DM resulted to higher cholesterol concentration compared to control diet.

In dairy cows, BCS was increased in EO cows compared with control cows (P<0.01; Fig. 2) at day 30 and 50 of experiment. In agreement with our results, Tedesco *et al.,* (2001) reported that transition cows supplemented with EO (silymarin) had lower body condition loss compared to un-supplemented cows.

CONCLUSION

We conclude that supplementation with a blend of EO can be useful nutritional modification to alleviate the decreased DMI and improve energy status in early lactating dairy cows.

ACKNOWLEDGMENT

The authors appreciate the employees of the Natural Resources & Agricultural research farm of the Tehran University Karaj for animal care.

REFERENCES

Anonymous. (1995). Iranian Council of Animal Care: Guide to the Care and Use of Experimental Animals, vol **1**. Isfahan University of Technology, Isfahan, Iran.

Benchaar, C., Petit, H.V., Berthiaume, R., Ouellet, D.R., Chiquette, J. and Chouinard, P.Y. (2007). Effects of essential oils on digestion, ruminal fermentation, rumen microbial populations, milk production, and milk composition in dairy cows fed alfalfa silage or corn silage. *Journal of Dairy Science.* **90**: 886-897.

Calsamiglia, S., Busquet, M., Cardozo, P.W., Castillejos, L. & Ferret, A. (2007). Invited review: essential oils as modifiers of rumen microbial fermentation. *Journal of Dairy Science.* **90**: 2580-2595.

Cardozo, P.W., Calsamiglia, S., Ferret, A. & Kamel, C. (2004). Effects of natural plant extracts on ruminal protein degradation and fermentation profiles in continuous culture. *Journal of Animal Science.* **82**: 3230-3236.

Chaves, A.V., Stanford, K., Dugan, M.E.R., Gibson, L.L., McAllister, T.A., Van Herk, F. & Benchaar, C. (2008). Effects of cinnamaldehyde, garlic and juniper berry essential oils on rumen fermentation, blood metabolites, growth performance, and carcass characteristics of growing lambs. *Livestock Science.* **117**: 215-224.

Devant, M., Anglada, A. & Bach, A. (2007). Effects of plant extract supplementation on rumen fermentation and metabolism in young Holstein bulls consuming high levels of concentrate. *Animal Feed Science and Technology.* **137**: 46-57.

Fandi˜no, I., Calsamiglia, S., Ferret, A. & Blanch, M. (2008). Anise and capsicum as alternatives to monensin to modify rumen fermentation in beef heifers fed a high concentrate diet. *Animal Feed Science and Technology.* **145**: 409-417.

Geraci, J.I., Garciarena, A.D., Gagliostro, G.A., Beauchemin, K.A. & Colombatto, D. (2012). Plant extracts containing cinnamaldehyde, eugenol and capsicum oleoresin added to feedlot cattle diets: Ruminal environment, short term intake pattern and animal performance. *Animal Feed Science and Technology.* **176**: 123-130.

Giannenas, I., Skoufos, J., Giannakopoulos, C., Wiemann, M., Gortzi, O., Lalas, S. & Kyriazakis, I. (2011). Effect of essential oils on milk production, milk composition, and rumen microbiota in Chios dairy ewes. *Journal of Dairy Science.* **94**: 5569-5577.

Hayirli, A., Keisler, D.H. & Doepel, L. (2011). Peripartum responses of dairy cows to prepartal feeding level and dietary fatty acid source. *Journal of Dairy Science.* **94**: 917-930.

Hosoda, K., Kuramoto, K., Eruden, B., Nishida, T. & Shioya, S. (2006). The effects of three herbs as feed supplements on blood metabolites, hormones, antioxidant activity, IgG concentration, and ruminal fermentation in Holstein steers. *Asian Australasian Journal of Animal Sciences.* **19**: 35-41.

Kung, J.L., Williams, P., Schmidt, R.J. Hu, W. (2008). A blend of essential plant oils used as an additive to alter silage fermentation or used as a feed additive for lactating dairy cows. *Journal of Dairy Science.* **91**: 4793-4800.

Liepa, G.U., Beitz, D.C. & Linder, J.R. (1978). Cholesterol synthesis in ruminating and nonruminating goats. *Journal of Nutrition.* **108**: 535-543.

Patra, A.K. (2011). Effects of essential oils on rumen fermentation, microbial ecology and ruminant production. *Asian Journal of Animal and Veterinary Advances.* **6**: 416-428.

Sahraei, M., Pirmohammadi, R. & Payvastegan, S. (2014). The effect of rosemary (*Rosmarinus officinalis* L.) essential oil on digestibility, ruminal fermentation and blood metabolites of Ghezel sheep fed barley-based diets. *Spanish Journal of Agricultural Research.* **12**: 448-454.

Santos, M.B., Robinson, P.H., Williams, P. & Losa, R. (2010). Effects of addition of an essential oil complex to the diet of lactating dairy cows on whole tract digestion of nutrients and productive performance. *Animal Feed Science and Technology.* **157**: 64-71.

SAS Institute. (2002). SAS User's Guide: Statistics. Release 9.1. SAS Institute Inc., Cary, NC.

Shaver, R.D. & Tassoul, M.D. (2008). Essential oils as dietary supplements for dairy cows. Mid-Atlantic Nutrition Conference, Baltimore, MD.

Spanghero, M.A., Salem, Z.M. & Robinson, P.H. (2009). Chemical composition, including secondary metabolites, and rumen fermentability of seeds and pulp of Californian (USA) and Italian grape pomaces. *Animal Feed Science and Technology*. **152**: 243-255.

Tassoul, MD. and Shaver, R.D. (2009). Effect of a mixture of supplemental dietary plant essential oils on performance of periparturient and early lactation dairy cows. *Journal of Dairy science.* **92**: 1734-1740.

Tedesco, D. (2001). The potentiality of herbs and plant extracts as feed additive in livestock production. *Zootec Nutrition Animal.* **3**: 111-133.

Tekippe, J.A., Tacoma, R., Hristov, A.N., Lee, C., Oh, J., Heyler, K.S., Cassidy, T.W., Varga, G.A & Bravo, D. (2013). Effect of essential oils on ruminal fermentation and lactation performance of dairy cows. *Journal of Dairy science.* **96**: 7892-7903.

Wall, E.H. Doane, P.H., Donkin, S.S. & Bravo, D. (2014). The effects of supplementation with a blend of cinnamaldehyde and eugenol on feed intake and milk production of dairy cows. *Journal of Dairy science.* **97**: 25709-5717.

Wallace, R.J. (2004). Antimicrobial properties of plant secondary metabolites. *Proceedings of the Nutrition Society*. **63**: 621-629.

Yang, W.Z., Ametaj, B.N., Benchaar, C., He, M.L. & Beauchemin, K.A. (2010). Cinnamadehyde in feedlot cattle diets: Intake, growth performance, carcass characteristics and blood metabolites. *Journal of Animal Science*. **88**: 1082-1092.

Zebeli, Q., Sivaraman, S., Dunn, S.M. & Ametaj, B.N. Intermittent parenteral administration of endotoxin triggers metabolic and immunological alterations typically associated with displaced abomasum and retained placenta in periparturient dairy cows. *Journal of Dairy science.* **94**: 4968-4983.