The Effects of Clove and Cinnamon Oils on Milk Yield and Milk Composition of Dairy Goats

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Abstract

The aim of the present study was to evaluate the effect of oral infusion of clove (CO, eugenol) and cinnamon essential oils (CIN, Cinnamaldehyde) on milk yield and milk composition of lactating German Fawn goats. Only few studies examined in vivo the effects of the essential oils and their combination on performance of dairy goats. Forty lactation German Fawn Goats having 46.2±1.9 kg live weight, 84±9 day in milk and 1.52±0.32 kg milk/day were allocated in 4 treatment. The treatments were 1) control, 2) oral infusion with 1.8 g/d CO, 3) oral infusion with 1.8 g/d CIN, 4) oral infusion with combination of CO (1,8 g/d) + CIN (1.8 g/d) which were assigned and analyzed in two by two factorial arrangement in a completely randomized designed. Goats were fed ad libitum with total mixed ration (TMR) contaning 60% concentrate and 40% alfalfa hay sized 1-2 cm, and had free access to water at all time. Oral infusion of essential oil was made everyday in te morning for 5 weeks experimental period. Oral infusion of CO, CIN and their combination had no significant effect ($P > 0.05$) on dry matter intake (DMI), milk yield, fat corrected milk yield (FCM) and milk composition (TS, SNF, Fat, Protein, Lactose, Casein and urea) concentration. The results revealed that essential oil may not have any effect on milk yield and milk composition under the feeding condition of 60/40 concentrate roughage ratio in the relatively lower yielding dairy goats

Keywords: Clove Oil, Cinnamon Oil, Dairy Goat, Milk Production, Milk Composition

INTRODUCTION

Public awareness of the potential health risk and environmental problem caused by the excessive use of in-feed antibiotics, growth hormones and some pharmaceutical food production lead to prohibition of some antibiotics since 1998 in EU member state. Some antibiotics have been banned completely by regulation (EC) 1831/2003 since 2006. In other country, including USA, the regulation for antibiotics ban is until now less legislative regulation. Feed additives are defined by regulation EC 1831/2003 in EU member state as substances or preparations which are intentionally added to feed or water in order to affect the characteristic of feed, animal product, environmental consequences and animal performance. Aromatic herbs and essential oils are prospectus organic feed additive in ruminants industry because of their characteristics.

Some aromatic herbs and essential oils which have been used to animal health management may substitute the using of chemical antibiotics and growth hormone. Current interest in ruminant animal production industry is focused on trying to improve production efficiency in animals with using essential oils . The focus interest is also trying to combine the use of essential oils to improve animal performance and reduce environment effect (Methane emission and ammonia excretion).

Major component of clove essential oils is eugenol and b-caryophilene (Kung et al, 2008). Patra et al. (2009) reported that eugenol contains in clove oils is 78%. Eugenol is a phenol which has high contains (74.5%) in stem part of clove. Some in vitro research of clove essential oils and euogenol oil from doses 3 to 5000 mg/L in vitro fermentation culture was reported had effect on all of rumen fermentation products (Busquets, 2005) decreasing VFA concentration (Busquet, 2005; Castillejos et al., 2006). In vivo experiments using used blend oils contain eugenol (Agolin ruminant) 0.5 g/day/cow which had no effected on dry matter intake and milk yield, but increased fat contain in milk (Santos, 2010).

Cinnamon essential oils have major component cinnamaldehyde and eugenol. Some in vitro experiments using cinnamon oils or cinnamaldehyde show different effect on rumen microbial fermentation, protein metabolism, VFA production, methane production and ciliate protozoa depend on doses and in vitro culture system. Cinnamon leaf essential oil (500 mg/L) containing 76% eugenol decreased ammonia N Concentration, molar proportion of branched-chain VFA (Fraser et al., 2007), proportions of acetat and increased proportions of propionate and butyrate at doses 312 mg/L (Busquet et al 2005b). Cinnamon leaf oil (250 mg/L) also reduced methanogenesis activity of rumen bacteria and methane concentration in the fermentation gases, without altering total VFA (Chaves et al. 2008). In vivo studies reported that reported that supplementation of cinnamaldehyde (200 mg/kg of dry matter) had no effect on dry matter intake, gain, feed efficiency carcass characteristics, meat quality and rumen ammonia N concentration in growing lamb fed barley or corn-based diets (Chaves, 2008).

Combination of cinnamon leaf oil (250 mg/L) and eugenol (800 mg/L) had no effects on deaminative activity of rumen bacteria and ammonia N Concentration in vitro (Benchaar et al 2008). But Cardozo et al. (2006) reported that combination between cinnamaldehyde and eugenol (180 mg/day cinnamaldehyde + 90 mg/day eugenol; 660 mg/day cinnamaldehyde + 300 mg/day of eugenol) affected N metabolism in the rumen by increasing the concentration of small peptide plus amino acid N and decreasing ammonia N concentration. Only few studies have examined in vivo the effects of clove and cinnamon essential oils and their main components on animal performance, especially in dairy goats. The Combination between essential oils or their components may result in additive and/or synergitic effects that may enhance efficiency of rumen microbial fermentation and nutrient utilization in ruminants. Thus, this research was evaluated combination effect between 1.8 g/day clove oil (97.26% eugenol) + 1.8 g/day of cinnamon oil (17.70% cinnamaldehyde) on milk production and milk composition of lactation german fawn goats.

Materials and Methods

Experimental Animal

Forty lactating German Fawn Goats were selected from Experimental Farm of Faculty of Agriculture, Cukurova University. During 2 weeks adaptation period, they were accustomed to experimental pen and the total mixed ration (TMR) contaning 60% concentrate and 40% alfalfa hay sized 1-2 cm, and had free access to water at all time. The goats were classified to 4 group of treatments by using milk yield pre-experimental period, live weight, and day in milk data. They had 46.2±1.9 kg live weight, 84±9 day in milk and 1.52±0.32 kg milk/day.

Experimental Design and Essential Oils Infusion

After adaptation period, goats received similar level of maintenance energy and protein from total mix ration (TMR) containing 60% concentrate and 40% alfalfa hay

according international (NRC, 2007) standard. Concentrated feed comprised of barley, corn, corn brand, middling, soya bean meal, limestone, salt, molasses and vitamin mineral. Goats were divided into 4 group of infusion of clove oils and cinnamon oils. Thus four group were :

- Control
- Infusion of Clove oils (CO) 1,8 g/day
- Infusion of Cinnamon oils (CIN) 1.8 g/day
- Infusion of Clove oils (1.8 g/day) and Cinnamon oils (1.8 g/day)

Infusion of essential oils was made every day at 8 am after morning feeding by oral infusion during 5 weeks experimental period. Clove oils and cinnamon oils were given 1.8 g or 300 ppm of 6 litre of liquid part of goat rumen fluid. With assumption that volumes of the reticulo-rumen of goats receiving hay and pasture is 0.5 litre/Kg $W^{0.75}$(Al Rahmoun, 1985) containing 70% liquid (Silanikove, 2001).

Chemical Analysis

Samples of feed were analysed for DM, ash, crude protein, crude fat and crude fiber according to Weende analysis system. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) of feeds were analyzed according to Van Soest method system (Van soest et al. 1991) using alpha-amlase and sodium sulfite and expressed without residual ash.

Estimation of Nutrient Availability and Feed Intake

Nutrient and energy requirements for lactation goats were described by standart of nutrient requirement of small ruminant (NRC, 2007). Total mixed ration containing 60% concentrated and 40% alfalfa hay was formulated to meet the nutrient requirements of mature dairy goat mid lactation (weight 50 kg, milk production 1.66 kg/day). Nutrient intake was measured from weekly feed intake during 5 weeks experiment period)

Milk Production and Milk Quality, and Performance Analysis

Animals were milked at 05:00 in the morning and at 17:00 in the afternoon in automatic milking system and milk samples were taken from morning and afternoon milk and analsed by Milkoscan FT-120 (Foss, DK) twice a week during 5 weeks experimental period. Composition was recalculated according to portion of morning and afternoon milk in total milk. Feed intake and weight were measured in the same time once a week.

Statistical Analysis

The data were analyzed by using GLM procedure of SAS 9.1.3 for windows (SAS ins. 1987) statistical package. The main effects of the statistical model were clove oils and cinnamon oils and interaction effect of the statistical model was combination clove oils cinnamon oils. All treatments were assigned in two by two factorial arrangement in a completely randomized design. The model used was as follow

$$Yijk = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ijk}$$

Here Y_{ijk} is the observed value for a dependent variable on $i^{.th}$ clove oil level (i = 1,2), $j^{.th}$ cinnamon oil level (j=1,2) with μ is the general mean and e_{ijk} as the random error.

Result and Discussion

Feed Quality and Consumption

The chemical composition and the estimated ME content of diets are given in Table 1. The diets were adequate in dry matter consumption, crude protein requirement and total metabolism energy (ME) requirements relative to the NRC (2007) recommendation (Table 2). This mean that total mixed ration containing 60% concentrated feed and 40% alfalfa hay is more than enough for nutrients requirements of goats in this experiments.

Table 1. Chemical composition of concentrated feed (CF), Alfalfa Hay (AH) And Total Mixed Ration (TMR) offered during 5 weeks of Experiemts period

Nutrient	Diet		
Contains	Concentrated Feed	Alfalfa Hay	TMR
DM(%)	99.25	99.39	99.31
OM(%)	92.67	92.33	92.53
CP (% of DM)	18.80	11.65	15.94
Cfat (% of DM)	1.47	1.65	1.55
Cfibre (% of DM)	9.00	31.47	17.99
NFE (% of DM)	63.40	47.56	57.06
Ash (% of DM)	7.33	7.67	7.47
NDF (% of DM)	25.86	56.33	38.05
ADF (% of DM)	14.81	44.68	26.75
ME (MJ/kg DM)	11.61	9.53	10.78
DE (MJ/kg DM)	14.15	11.63	13.14
Nem (MJ/kg DM)	12.61	8.50	10.76
Neg (MJ/kg DM)	10.46	6.64	8.71
Nel (MJ/kg DM)	8.16	6.70	7.58

Standart ME requirements of mature dairy goats (mid lactation, 50 kg weight and 1.66 kg milk production) is 18.14 MJ/day lower than ME consumption of different goat treatments (23.39 Mj/day – 24.36 MJ/day). Other nutrients consumption, such protein and dry matter intake also higher than requirements. Oral infusion of 1.8 CO, CIN and their combination had no effect on feed and nutrients consumption. Dry matter intake (g/kg $W^{0.75}$) ranges between 117.61 – 124.25 g/kg $W^{0.75}$ which fall in the range of 47-181 g/kg$W^{0.75}$ for temperate lactating goats (Sauvant et al 1991).

Effects of oral infusion CO, CIN and their combination on milk production and quality

Oral infusion of clove, cinnamon and their combination had no significant ($P>0.05$) effect on milk production, fat corrected milk 4%, and live weight change. Milk component were not affected ($P>0.05$) by both essential oil and their combination as well. Theses result might be related to similar nutrient intake of all treatment groups. Main constrains for milk yield and milk protein and fat synthesis is energy and protein intakes. However energy and nutrient intakes are above the does in all experimental groups. This means essential oil may not give advantage to supply extra nutrient by improving rumen environment and nutrient utilization. It also result in no effect of CO and CIN on milk composition. average value if milk composition such as total solid (TS) solid non fat (SNF), Fat, Protein, casein and lactose were same between treatments cause the same intake of nutrient.

Furthermore essential oil effectiveness may be decreased by oral infusion once a day due to rumen outflow rate.

Table 2. Nutrient consumption of different treatments of oral infusion of clove and cinnamon essential oils in mid lactation german fawn goats.

Nutrient	CO-0		CO-1.8	
	CIN-0	CIN-1.8	CIN-0	CIN-1.8
DM (Kg/day)	2.22	2.24	2.15	2.20
OM (Kg/day)	2.07	2.09	2.01	2.05
CP (g/day)	357.03	360.22	345.87	353.84
Cfat (g/day)	34.62	34.93	33.54	34.31
Cfibre (g/day)	402.91	406.50	390.32	399.31
NFE (g/day)	1278.22	1289.63	1238.27	1266.80
Ash (g/day)	167.23	168.72	162.00	165.74
NDF (g/day)	852.27	859.88	825.64	844.66
ADF (g/day)	599.31	604.66	580.58	593.96
ME (MJ/day)	24.14	24.36	23.39	23.92

Table 3. Effect of oral infusion of clove (CO) and cinnamon essential oils (CIN) on feed intake (FI), dry matter intake (DMI), live weight(LW), live weight change (LWC) and milk yield (MY), Fat Corrected Milk (FCM) after 5 weeks experiment periode

	CO-0		CO1.8			P <0.05		
	CIN-0	CIN1.8	CIN-0	CIN1.8	SE	CO	CIN	CO*CIN
LW (kg)	46.86	50.47	48.72	51.18	19.5	0.57	0.23	0.83
FI (Kg/day)	2.24	2.26	2.17	2.22	0.04	0.14	0.35	0.71
DMI (kg/day)	2.21	2.23	2.15	2.2	0.03	0.13	0.3	0.63
DMI ($g/kgw^{0.75}$)	124.25	119.09	117.61	120.05	3.54	0.44	0.62	0.33
MY (kg)	1.46	1.56	1.62	1.41	0.1	0.97	0.59	0.15
FCM(kg)	1.51	1.61	1.7	1.52	0.1	0.61	0.68	0.17
LWC(g/day)	111.9	74.76	139.29	110.36	2.85	0.11	0.07	0.82
DMI/FCM	1.54	1.41	1.32	1.51	0.11	0.51	0.74	0.1

Table 4. Effect of oral infusion of clove (CO) and cinnamon essential oils (CIN) on milk composition (TS, SNF, fat, protein, lactose and casein) after 5 weeks experiment periode

	CO-0		CO1.8			P <0.05		
	CIN-0	CIN1.8	CIN-0	CIN1.8	SE	CO	CIN	CO*CIN
FCM(kg)	1.51	1.61	1.7	1.52	0.1	0.61	0.68	0.17
TS (%)\	12.75	12.97	12.91	13.18	0.04	0.27	0.35	0.93
SNF (%)	8.45	8.7	8.44	8.59	0.03	0.16	0.22	0.78
FAT (%)	4.24	4.22	4.4	4.55	3.54	0.17	0.69	0.59
PROTEIN (%)	3.51	3.59	3.51	3.63	0.1	0.11	0.34	0.88
LACTOSE (%)	4.27	4.37	4.21	4.25	0.1	0.07	0.33	0.63
CASEIN (%)	2.75	2.84	2.74	2.87	2.85	0.09	0.2	0.84

Conclusion

The results revealed that essential oil may not have any effect on milk yield and milk composition under the feeding condition of 60/40 concentrate roughage ratio in the relatively lower yielding dairy goats. Combination effect of clove oils 1.8 g/day with cinnamon oils 1.8 g/day had no synergic or addition effect to increase milk production and change milk composition.

Refference

Alrahmoun. w., 1985. Utilisation digestive comparee chez les caprins et les ovins : effects de la nature du regme, du traitement des pailles par la soude, de la nature dela source azolee (Digestive utilization in goats and sheep. Effect of diet, NaOH treated straws, kind of nitrogen souces). Theses Univeriste de Dijon (France).

Busquet, M., S. Calsamiglia, A. Ferret. P. W. Cardozo, and C.Kamel. 2005. Screening for the effects of natural plant extracts and secondary plant metabolites on rumen microbial fermentation continuous culture. Anim. Feed Sci. technol. 123:597-613.

Chaves A. V., stanford K., Dugan, M. E. R., Gibson L. L., McAllister T. A., Van Herk F., Benchaar C., 2008. Effect of Cinnamaldehyde, garlic and Juniper Berry essential Oils on Rumen Fermentation, Blood metabolites, Growth Performans, and carcas Characteristıcs of Growing Lambsç Animal feed Science and tech. 117:215*224

Fraser, G. R., Chaves A. V., Wang, Y., McAllister, T. A., Beauchemin, K. A., Benchaar, C., 2007. Assesstment of the effects of Cinnamon leaf oils on rumen microbial fermentation using Two continuous culture systems, J. Dairy Sci. 90:2315-2328

Helander M. Alakomi H, Latva-kala K, Mattilla-Sandholm T, Pol I, Smid EJ, Gorris LGM and Wright AV (1998) Characteristics of the action of selected essential oil components on gram negative bacteria. Journal of agricultureal and food chemistry 46 : 3590-3595

Kung, L., Williams, P., Schmidt, R. J., Hu W., 2008. A Blend of Essentials Oils Used an Additive to Alter Sillage Fermentation or Used as a feed Additive for Lactating Dairy Cows. J. Dairy Sci., 91:4793-4800

NRC. 2007. Nutrients requirements of small ruminants.(sheep, goat, cervids and new word camelide). The National academic press. Washington DC.

Patra AK., DN Kamra, N Agarwal. 2009. Effects of extracts of spices on rumen methanogenesis, enzyme activities and fermentation of feeds *in vitroJ. J. Sci Food Agric* 2010; 90: 511–520

Silanikove, N., N. Gilboa, Z. Nitsan. 2001. Effect of polyethylene glycol on rumen volume and retention time of liquid and particulate matter along the digestive tract in goats fed tannin-rich carob leaves (Ceratonia siliqua). Small Rumin. Res. 40, 95-99.

Santos, M. B. P.H. robinson., P. Williams and R. Losa. 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. J. Of Anim. Feed Sci. Technol. 157(2010) : 64-71.