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The Effects of Essential Oils Dietary Supplementation on Feeding Behavior of Sheep under Organic Animal Husbandry

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Abstract: The objective of this study was to evaluate the effect of oregano and garlic essential oils dietary supplementation on the feeding behavior of two different sheep breeds (Anatolian Merino sheep (Anatolian Merino) and Polatli sheep (Polatli)). Twenty male sheep (ten from each breed) were randomly assigned in two groups: oregano and garlic. The experiment was divided into pre-experiment and main experiment periods. The same organic concentrate was offered for all animals all over experimental period while organic concentrate was supplemented with oregano or garlic essential oils supplementation only (5000 ppm kg^{-1}) during the main experiment stage. The organic concentrate was offered to sheep in the 2 times day^{-1} (morning feeding at 8:00, afternoon feeding at 16:00). Individual feeding behaviors (number of meals and meal duration) were recorded using digital camera all over 24 h. The number of meals and meal duration had been increased in oregano group at the main experiment compared to the pre-experiment ($p<0.01$). At the main experiment, sheep of oregano group were unwilling to eat and had higher number of meals in comparison to sheep of garlic group ($p<0.01$). Moreover, Polatli group fed oregano oil had higher number of meals compared to Anatolian Merino ($p<0.01$). Sheep fed oregano consumed the offered concentrate feed but in longer time compared to sheep of garlic group ($p<0.01$) at the main experiment. Essential oil did not affect the number of meals at the morning and afternoon feeding times as well as sheep from different breeds showed similar response. Anatolian Merino fed on oregano oil showed shorter meal duration during morning feeding compared to afternoon feeding ($p<0.01$). Researchers concluded that the feeding behaviors of sheep had been affected by essential oil the dietary supplementation, especially oregano oil. It can be say that Polatli sheep had higher sensitivity to the changes in the diet compared to Anatolian Merino.

Key words: Organic livestock husbandry, sheep, essential oil, feeding behavior, Egypt

INTRODUCTION

The main aim of organic livestock husbandry is eliminating synthetic feed additives, therefore there is a need for more information about the potentiality natural sources (Novoa-Garrido *et al*., 2012). Oregano (*Origanum vulgare* L.) and garlic (*Allium sativum* L.) oils have been reported as effective feed supplements in animal's diets. Oregano oil is a plant extract that contains mainly carvacrol, thymol which are the major phenols that constitute about 78-82% of the essential oil. Moreover, it has antifungal (Daouk *et al*., 1995) and antimicrobial properties (Dorman and Deans, 2000) which make it an appropriate organic alternative for antibiotic as well as a promising feed additive in order to prevent meat lipid oxidation (Simitzis *et al*., 2008a). Although, the negative effects of oregano oil on feeding and drinking behavior and the activity of broilers, it has been showed promising on the growth performance and the meat quality (Symeon *et al*., 2010). The essential garlic oil has unique compounds which is not found in the original plant. These compounds are produced from thiosulfates during the steam extraction (Pentz and Siegers, 1996) and have very active medical properties against wide range bacteria, fungi, parasites and viruses (Reuter *et al*., 1996). Anassori *et al*. (2011) stated that raw garlic and garlic oil can modify rumen microbial populations and their activities. It has the potentiality to improve rumen fermentation efficiency by increasing the production of propionate and reducing protozoa population. These medical and beneficial properties of essential oils are very important for organic livestock because of the limited usage of chemically synthesized allopathic veterinary medicinal products. Available background about feeding behavior of small ruminants was insufficient (Keskin *et al*., 2005). Recently, the interest in the topics of

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feeding behavior in ruminants has been increased (Arslan, 2009; Gorgulu *et al*., 2011). Further, research about the toxicity to animals, palatability and effects on organoleptic quality of animal products are required to ensure that the essential oils can be safely used to enhance animal productivity and reduce the impacts of animal production on the environment (Benchaar and Greathead, 2011).

The objective of the study was to investigate the effect of garlic and oregano essential oils dietary supplementation on feeding behaviors (total number of meals and meal duration) of two local Turkish sheep breeds under organic animal husbandry.

MATERIALS AND METHODS

Experimental animals and husbandry practices: Anatolian Merino sheep (from German mutton Merino, 80% and native White Karaman, 20%) and Polatli Sheep (from Ile de France, 75% and native White Karaman, 25%) of 9 months yearling male (registered as local breeds, 2004 and 2010, respectively) (Ertugrul *et al*., 2011) were used. The experiment were done between the 25th of November and 6th of December in 2012 (total 12 days: 5 days pre-experiment, 7 days main experiment) at Ege University, Odemis Vocational School Experiment Farm at Izmir (38°13'03"North, 27°57'50"East) under organic animal husbandry conditions. All sheep numbered using henna to be observed separately during the experimental time. Twenty sheep (ten from each breed) were housed in 2 identical pens (5 from Anatolian Merino, 5 from Polatli were kept at the same pen) with the same direction and orientation they were equipped with similar concrete troughs for feeding. The pen has 4.1 m^2 per sheep and 55 cm on troughs per sheep. Every sheep had free access to 5 m^2 outdoor run. Because of the autumn season, the lights were kept open from 17:00-24:00 to observe the feeding behavior of sheep. All sheep cared according to veterinary recommendations.

Feeds and diets: All feeds used to prepare concentrate were organic. The certificate number of maize, soybean meal, wheat and barley was TR-OT-OO2-I-0108-4612 (IMO-Turkey), certificate number of lucerne hay was TR-OT-O22-12.807319. D002 (Control Union-Turkey), the certificate number of oils was TR-OT-003-1848TR1200Z010 (ECOCERT-Turkey). The organic concentrate formulated to meet minimum NRC (1985) standards and daily dry matter intake were calculated approximately 4% of body weight during the experimental periods. The organic concentrate was offered to sheep as a maximum 40% of dry matter intake on dry matter divided into two meals/day (morning feeding at 8:00, afternoon feeding at 16:00). Organic concentrate feed were prepared and mixed carefully with oregano or garlic essential oils (5000 ppm kg^{-1}) every 2 days during the main experimental period. After that feed were packed in black plastic bags which were sealed firmly to minimize the evaporation of essential oils. Sheep had a free access to lucerne hay and water all over the experimental period. The ingredients of organic concentrate consist of maize (371.5 kg ton^{-1}), soybean meal (140 kg ton^{-1}), wheat (350 kg ton^{-1}), barley (110 kg ton^{-1}), mineral premix (1 kg ton^{-1}), salt (4 kg ton^{-1}), di-calcium phosphate (5.5 kg ton^{-1}) and marble powder (18 kg ton^{-1}). Mineral premix provides per kg: Mn; 50.000 mg, Fe; 50.000 mg, Zn; 50.000 mg, Cu; 10.000 mg, I; 800 mg, Co; 150 mg, Se; 150 mg. The chemical composition of organic concentrate and chemical composition of Lucerne hay were shown in (Table 1). The chemical compositions: dry matter, organic matter, crude protein, ether extract, calcium and total phosphorus were determined using AOAC (1995) Method and crude fiber by Lepper Method (Crampton and Maynard, 1937). *In vitro* metabolizable energy contents of organic concentrate and Lucerne hay were calculated by their crude nutrient contents (TSE, 2004).

Experimental treatments and behavioral test: The experiment was divided into two periods: Pre-experiment (5 days) and main experiment (7 days). The same organic concentrate was offered for all animals all over experimental period while oregano or garlic essential oils supplementation (5000 ppm kg^{-1}) was done during the main experimental stage. Individual feeding behavior (total meal duration and number of meals) were recorded by using with Avenir mark AU-548 Model camera (camera 1/3" Sony Super HAD CCD) with 4/6 mm lens for 24 h during the pre and main experimental periods. The cameras were mounded 3 m from floor level in fixed position in each pen. The recorded tapes were later played in a video recorder TV set and analyzed in detail. The examined behavior elements: total meal duration; cumulative duration of acts of eating on trough, number of meals; acts of eat one time. The sheep were handled by the same person during the experimental periods. The

Table 1: The chemical composition of organic concentrate and lucerne hay used in experiment 1

Chemical composition	Organic concentrate (g kg^{-1} feed)	Organic lucerne hay (g kg^{-1} feed)
Dry matter	886.70	921.20
Organic matter	866.20	824.30
Crude protein	151.30	137.30
Ether extract	36.90	15.70
Crude fiber	34.00	247.70
Ca	8.50	11.00
Total P	4.60	2.00
ME (MJ kg^{-1} feed)	12.07	7.55

[1]ME: Metabolizable Energy

Table 2: The fattening performance parameters of sheep (n = 5) during main experiment period 1

	Oregano		Garlic		
Parameters	Anatolian Merino	Polatli	Anatolian Merino	Polatli	SE
ILW (kg)	66.830	66.680	68.360	66.400	1.12
FLW (kg)	68.500	68.500	69.790	67.690	1.14
DWG (kg)	0.238^{ab}	0.260^{a}	0.202^{b}	0.186^{b}	0.01
CFO (kg day^{-1})	1.069	1.067	1.094	1.062	0.02

[1]ILW: Initial Live Weight; FLW: Final Live Weight; DWG: Daily Weight Gain; CFO: Concentrate Feed Offered kg/day/sheep on dry matter; SE: Standart Error of mean; different letters in the same row are statistically different ($p<0.05$)

sheep were balanced before and at the end of the main experiment period. Table 2 shows the fattening performance of sheep according to the treatments during the main experiment.

Statistical analyses: All tests were carried out using the statistical package of SPSS 15.0® (2005). The data on the fattaning performance were analyzed using Genel Linear Model procedure (two-way anova) and the Duncan test was used to compare the means when significant differences occurred.

Variables of behavioral feeding activity (No. of meals and meal duration) clearly deviated from normal distribution. Thus, non-parametric analyses were employed. The number of meals (%) was calculated dividing the count of each number of meals in each time period by the number of total observation in that time period. The Friedman-Anova analysis followed by Student-Newman-Keuls test was used to verify for significantly different effects of essential oils and breeds.

RESULTS AND DISCUSSION

Differences in techniques used to measure feeding behavior, animal age and species, housing and diet made some difficulties for the direct comparison of this study with the previous reports. Feed characteristics appear to influence feeding intensity within a given meal. Variations in eating rates impact overall and actual meal duration (Wangsness *et al*., 1976). Gorgulu *et al.* (2011) stated that time spent eating and the pattern of meals has important effects on total daily intake of animals. In oregano oil group, Anatolian Merino and Polatli breeds, total number of meals had been increased during the main experiment compared to the pre-experiment period ($p<0.01$) (Fig. 1). On the other hand, sheep fed on garlic oil group did not show any differences (Fig. 1). Garlic oil did not show a noticeable effect on the meal duration while oregano oil increased ($p<0.01$) the meal duration during the main experimental period (Fig. 1). Oregano essential oil supplementation affected feeding behavior which is in agreement with findings by Simitzis *et al.* (2005).

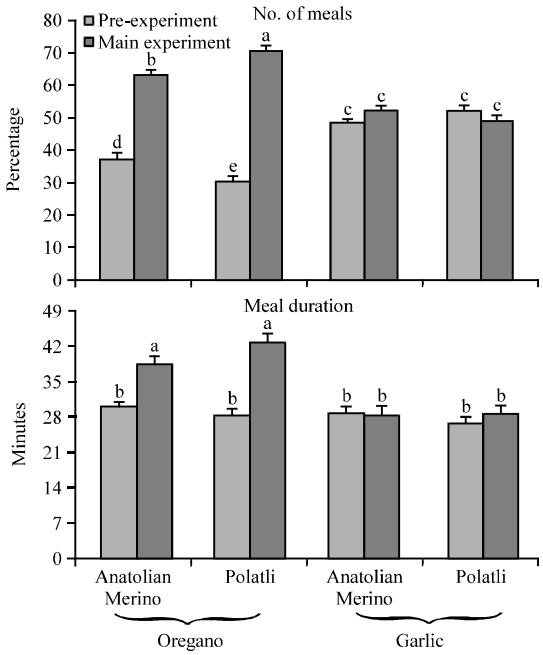

Fig. 1: The effect of essential oil supplementation on the number of meals (%) and meal duration (min/day) during the pre-experiment and main experiment periods at sheep (least squares means±standard error); [a-c]Means with different superscripts within number of meals and meal duration are statistically different ($p<0.01$)

Although, Polatli fed on oregano oil had the smallest total number of meals during the pre-experiment period they have the highest one compared to other groups during the main experiment period ($p<0.01$). This shows that breeds had different sensitivity to feed supplements which was reflected on their feeding behavior.

In addition, Polatli fed on oregano had the highest average daily weight gain (Table 2). It might be because of the higher consumption of lucerne hay and water. However, researchers did not record the consumptions of lucerne hay and water in each group. Gorgulu *et al.* (2011) stated that the difference in eating rates reflects the differences in overall meal duration. Thus, researchers found that garlic oil did not show a noticeable effect on the meal duration while oregano oil increased ($p<0.01$) the meal duration during the main experimental period (Fig. 1). Generally, the increase in the number of meals and average of meal duration might reflect the sheep efforts to deal with new concentrate feed supplemented with essential oils. The feed palatability was influnced by oregano essential oils supplementation and animal need more time to be adapted to the new formula (Fig. 1).

Table 3: Effect of essential oil supplementation on number of meals and meal duration by medians (interquartile range) at the main experiment period at sheep

	Oregano		Garlic	
Behavioral reactions	Anatolian Merino	Polatli	Anatolian Merino	Polatli
No. of meals (number day^{-1})	27 (19-37)^{b}	34 (28-44)^{a}	14 (10-17)^{c}	12 (9-16)^{c}
Meal duration (min day^{-1})	36.15 (28.87-48.55)^{a}	40.69 (34.06-52.57)^{a}	28.42 (24.35-31.47)^{b}	27.37 (23.88-32.80)^{b}

$^{a-c}$Means with different superscripts in the same row are statistically different ($p<0.01$)

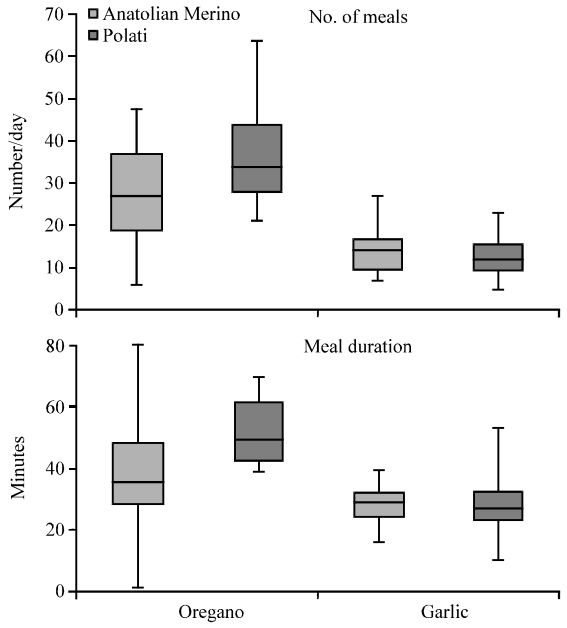

Fig. 2: Effect of essential oil supplementation on the number of meals and total meal duration by medians (interquartile range) for the Anatolian Merino and Polatli sheep breeds at the main experiment period

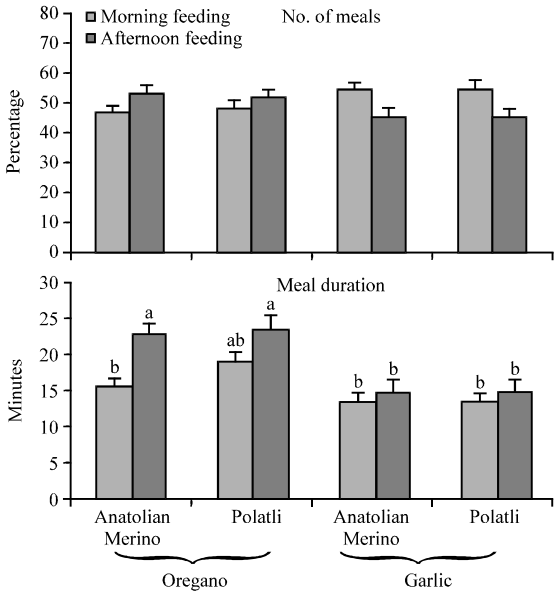

Fig. 3: The number of meals and meal duration of during morning and afternoon feeding times of Anatolian Merino and Polatli sheep fed on supplemented essential oils (least squares means±standard error); $^{a-c}$Means with different superscripts within meal duration are statistically different ($p<0.01$)

In Table 3 and Fig. 2, Polatli and Anatolian Merino received garlic oil showed similar feeding behavior. However, they had lower number of meals and meal duration compared to those received oregano oil ($p<0.01$). Although, Polatli and Anatolian Merino fed oregano oil showed similar total meal duration, Polatli had higher number of meals compared to Anatolian Merino ($p<0.01$).

Eventually, oregano sheep group consumed the offered concentrate feed but in longer time compared to sheep of garlic group ($p<0.01$). This might show that higher sheep preference for the concentrate feed sprayed with garlic oil in agreement with (Horton *et al*., 1991). This situation was similar to (Tager and Krause, 2011) that different essential oils can alter feeding behaviors. Increasing the number of meals which will caused to shortening the length of the meal may be beneficial in preventing acidosis as it may help control the sharp decrease in rumen pH after feeding as it can be stated in Tager and Krause (2011). So, it may give an advantage for oregano oil when it is being suggested as diet supplement. And this finding was similar to (Simitzis *et al*., 2008b) that the increased meal duration were found in oregano oil supplemented test feed. The average number of meals in sheep per day 8.94 and 8.48, respectively by Gorgulu *et al*. (2011) and Wangsness *et al*. (1976) and but this parameter is in the high range in ruminants (Wangsness *et al*., 1976). But similar results were reported for meal duration at sheep by Gorgulu *et al*. (2011) as in 20.67 min.

The essential oils and breed did not affect the number of meals at the morning and afternoon feeding times (Fig. 3). However, number of meals of both breeds showed similar trend during different feeding times, being numerically higher during afternoon feeding in oregano oil and morning feeding in garlic oil groups. Anatolian Merino fed on oregano oil showed shorter meal duration during morning feeding compared to afternoon feeding ($p<0.01$) (Fig. 3). This refers to that each animal breed may have its own feeding behavior. Garlic groups did not

show significant differences between meal duration during different feeding times. Gorgulu *et al*. (2011) stated that feeding behavior may vary among animal types, depending on productive and physiological status of the animal. Also, Simitzis *et al*. (2005) reported that different sheep had different sensitivity to the changes in the diets.

CONCLUSION

The results of this study showed that feeding behaviors had been affected by essential oil the dietary supplementation, especially oregano oil. Polatli sheep showed higher sensitivity to the changes in the diet compared to Anatolian Merino. Thus, animals should be handled in different ways according to sheep breed in case of using new feed additive.

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