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SEASONAL CHANGES IN DAILY BEHAVIORAL RHYTHMS OF GÖKÇEADA SHEEP GRAZED INTO RANGELAND WITH INTENSE PRICKLY BURNET (*SARCOPOTERIUM SPINOSUM*) COVER

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Abstract

In this study, seasonal changes in daily behavioral rhythms of Gökçeada sheep into the pastures were investigated. The research was conducted at Gökçeada Island located at the far-west end of Turkey in Aegean Sea. This study is a part of 3-year rangeland reclamation project. Experiments were conducted into 8 plots surrounded with fences including 3-4 years old 40 head sheep (0.15 ha/sheep) grazed into the rangeland for a year. Prickly burnet cover ratio was found between 71.4-88.2% in reclaimed plots 95.7-94.9% in control plots. The sheep were observed through directs observations with sampling method in day-time. Significant differences were observed in grazing behaviors of Gökçeada sheep in different seasons ($P<0.0001$). Grazing frequency was high in winter and spring seasons and low in summer season ($P\leq0.05$). The sheep grazed in winter and spring seasons 2 times higher than autumn season. Grazing frequency was quite low in summer season. The sheep grazed in summer season rather in cool hours of the morning and evening. They spent rest of the day with resting and rumination. They spent majority of the day with grazing in winter and spring seasons. It has been concluded in this study that Gökçeada sheep, raised almost under wild conditions, were able to self-sustain into the rangeland with dominant prickle burnet cover through efficiently benefiting from prickly burnet in all season.

Key words: *Gökçeada Island, pasture reclamation, seeding, day time, climate.*

INTRODUCTION

Prickly burnet (*Sarcopoterium spinosum*) is quite common over the garrigue vegetation of Mediterranean island rangeland (Lanteri et al., 2012). Several methods including burning, herbicide treatments, mechanical control (cutting or grubbing) and fertilization were practiced into the rangeland to control this invasive species (Papanastasis, 1980; Henkin et al., 1998; Perevolotsky et al., 2001; Henkin et al., 2007). It was indicated that grazing could also be a control practice over these sites (Bartolome et al., 2000). Undoubtedly, goats benefit from such sites in a best way (Papanastasis et al., 2008). However, sheep were reported more efficient in control of shrubbery lands with shrubs shorter than 0.5 m (Papachristou, 1997; Ferreira et al., 2013).

As it was in other sites with dominant Mediterranean climate, prickly burnet is widespread over the island vegetation of Gökçeada. Commonly found Gökçeada (Imbros) sheep and Gökçeada goat well adapted to plant cover and land topography are breeding in the island. Goat inventory of Gökçeada Island has been declining since 1982 because of the damages exerted on agricultural fields and pastures.

Prickly burnet is probably getting more common just because of decreased goat inventory of the island. Today, almost all of the dwarf shrubbery rangeland and 36.2% of total island surface area are covered with prickly burnet (Cengiz et al., 2009).

There is a long standing pastoral ruminant production system in Gökçeada Island (Aktürk et al., 2005; Tölü and Savaş, 2011). The island surface area is 286 km^2 and there are 46.414 head sheep and 16.191 head goats in the island (Anonymous, 2013a). While about 70% of ovine is raised freely under almost wild conditions, the rest is raised in sheep barns under human control but still mostly depend on

rangeland. Fully-free ones captured once in each year for lamb and fleece by humans and specially trained dogs.

Previous grazing studies mainly focused on domestic animals and there are several factors affecting in behavioral characteristics of the animals into rangeland (Ouedraogo-Kone et al., 2006; Sanon et al., 2007). Besides, there is limited number of studies carried out with wild or feral animals (Haris and O'Connor, 1980; Arnold, 1982). However, there aren't any studies about the grazing behaviors of free-range intensively raised Gökçeada sheep and their daily behavioral rhythms. Thus, the present study was conducted aimed to investigate the daily behavioral rhythms of Gökçeada sheep into the rangeland in different seasons.

MATERIALS AND METHODS

Study area

The present research was conducted in Gökçeada Island covering 286 km^2 land area and located at the far-west of Turkey in Aegean Sea (40°14'10.82" N latitude, 25°54'30.45" E longitude). Total precipitation in observation year was 869.1 mm (Anonymous, 2013b). Pasture soils are shallow, slightly alkaline, unsaline with sandy-loam texture, low lime content, medium organic matter content, high N, Ca and Mg contents, and very low P content and sufficient levels of K (Gökkuş et al., 2013).

This study is a part of pasture reclamation project implemented for 3 years to remove prickly burnet from the pasture applying different methods and to reclaim the rangeland through seeding with herbaceous plants. In October 2010, cutting, grubbing and burning have been practiced over the rangeland to control prickly burnet shrubs and natural pasture was separated as control plot. The plots with shrub control measures and the natural plots were divided into two parts and one of these parts was seeded with forage crop seeds. For direct seeding, mixture of 20% perennial ryegrass (*L. perenne)*, common crested wheatgrass (*A. cristatum)*, orchard grass *(D. glomerata)*, 15% alfalfa (*M. sativa)*, sainfoin (*O. viciifolia)* and 10% burnet (*P. sanguisorba)* seeds were sown at a rate of 100.75 kg/ha. Two years after rangeland reclamation practices, in December 2012, sheep were placed into the plots and their behavior activities have been observed for a year. In this study, daily behavioral rhythms of the sheep in different seasons were considered free of rangeland reclamation methods and seeding treatments. Each grazing plot was surrounded with fences having a size of 0.15 ha/sheep.

Animals

A herd containing 150 sheep, freely ranged over the rangeland and accustomed to feeding was used to select the experimental sheep. Among them, 40 sheep were selected based on age, live weight and body condition, and then they were randomly distributed to experimental plots having 5 sheep in each plot. Selected sheep with the age of 3-4 years and with the average live weight of 31.18±1.70 kg (Figure 1).

Sheep have been grazed freely into 8 rangeland plots. Paddocks of 12 m^2 were placed in each plot and they were looked like a shelter with close sided windward. Paddocks protected animals to the sun, precipitation and harsh winds. Supplementary roughage has also provided in paddocks. Water was supplied *ad libitum* in 30-liter plastic containers (Figure 1).

The sheep care practices were implemented by herdsman in morning as well as evening hours. For adaptation of sheep to rangeland, maize corn, to which the sheep were accustomed, was supplied from the first day of pasture. Concentrate feed was directly spread over the pasture and roughage was supplied in feeders in paddocks. Feed supply was provided as group feeding within each plot. Based on gestation, birth and lactation of the sheep, they were supplied with 100-300 g/sheep/day concentrate feed and 500 g/sheep/day alfalfa hay. Supplementary feeding did not show any performance between mid-April and the beginning of June.

Births intensified at the end of February and the starting of March. At the beginning of September, 8 Gökçeada sheep breed rams with 25-27 kg live weight and with the age of 2.5 years were placed into each plot. Rams were stayed with the sheep until the removal of the sheep from the pasture. Rams were selected from the sheep herd raised freely over Gökçeada Island pastures.

Behavior observations

The first behavioral observations were performed 15 days after placing the sheep into the rangeland.Then, monthly behavioral observations were performed.

Figure 1. Gökçeada sheep into rangeland plots (By Tölü)

All of the observations have been carried out by 4 observers through direct observations from dawn till dusk. Observers did not always observe the behaviors in the same plots. In behavioral observations, grazing (picking, chewing, searching, walking; etc. for consumption of plants), rumination (rumination in standing or lying position), locomotion (being in action without grazing), resting (lying or standing) like behaviors have been observed for a 10 min of intervals through time-sampling method. The sheep in each group were painted in different colors (Figure 1).

Plant measurements

To determine plant nutrient contents of rangeland vegetation, five sections (1 m^2) were cutting from the bottom in each season. Mowed samples were weighted to determine fresh weights, initially air dried and then dried at 60^oC for 48 hours to determine dry weights (Cook and Stubbendieck, 1986).

Rangeland plant cover was dominantly composed of prickly burnet (70-95%), while prickle burnet ratio was found between 71.4-88.2% in plots where control measures were implemented, the ratio was between 95.7-94.9% in case of natural rangeland plots.

Dry matter and ash analyses were performed in accordance with AOAC (2000), crude proteins determined with Kjeldahl method through wet ashing in salicylic-sulphuric acid mixture (Bremner, 1960).

Structural carbohydrate analyses (NDF, ADF) were carried out in accordance with Van Soest et al. (1991) and tannin analyses in accordance with Makkar et al. (1995).

Statistical Analyses

GEE (Generalized Estimating Equation)-based intermittent model for repetitive binomial distributions has been used to assess the animal behavioral characteristics.

Seasons (winter, spring, summer, autumn) were placed into the model as fixed factor.

Odds ratio, regression coefficients and standard error values of regression coefficients were used in the evaluation of the effects.

Odds ratio was defined as the ratio of observation to non-observation of behavior. Odds ratio was calculated from the equation of $\Psi = e^b$, where ψ is the odds ratio, b is the regression coefficient and e is the exponential constant. The *post-hoc* analyses were made according to the Wald chi-square test.

Then, the plant nutrient contents were subjected to variance analysis for repetitive measurements with a model containing seasons.

Pair wise comparisons were performed through Tukey test. SAS (1999) was used in for statistical analyses.

RESULTS AND DISCUSSIONS

Crude protein content and mineral matter contents of pasture plots increased in spring (Table 1). Natural pasture plots with low protein and ash contents and high NDF and ADF ratios were significantly different from the other groups ($P \leq 0.05$). Grazing behaviors of Gökçeada sheep were significantly different in all seasons (Table 2; $P < 0.0001$).

The largest grazing frequency was observed in winter and spring and the least grazing frequency was observed in summer ($P \leq 0.05$).

The sheep grazed in winter and spring for 2 times more than autumn and 3 times more than summer. Similar to the present study, grazing behaviors of the sheep grazed over natural rangeland of Northern Greece in winter and spring seasons were 2 times more than summer

and autumn (Evangelou et al., 2014). However, it is known that sheep stopped grazing activity throughout the time periods with increased ambient temperatures (Ferreira et al., 2013).

Table 1. Seasonal mean, standard error (SE) and significance levels for nutrient contents of rangeland vegetation

Nutrients	Winter		Spring		Summer		Autumn		P
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	
DM	70.05^{b}	1.14	59.85^{c}	0.78	58.58^{c}	0.89	88.15^{a}	0.39	<0.0001
CP	4.90^{b}	0.09	6.75^{a}	0.22	4.77^{b}	0.15	3.41^{c}	0.09	<0.0001
NDF	50.97^{c}	0.50	49.96^{c}	0.68	53.69^{b}	0.69	59.28^{a}	0.99	<0.0001
ADF	35.50^{b}	0.46	36.66^{b}	0.72	41.29^{a}	0.50	43.17^{a}	0.81	<0.0001
Ash	5.77^{b}	0.18	7.07^{a}	0.18	4.15^{c}	0.24	4.41^{c}	0.13	<0.0001
Tannin	1.48^{ab}	0.05	1.60^{a}	0.03	1.61^{a}	0.06	1.35^{b}	0.04	0.0024

DM: Dry matter, %; CP: Crude protein, % DM; NDF: Neutral detergent fiber, % DM; ADF: Acid detergent fiber, % DM; Ash: Crude ash % DM; Tannin: Tannin, %. The differences indicated with different letter in the same line within each nutrient are significant (P≤0.05).

The sheep rather grazed in morning and evening hours and probably kept grazing at night hours in this period.

Rumination behaviors of Gökçeada sheep were also significantly different throughout the all seasons (Table 2; P<0.0001). The most frequent rumination behavior was observed in summer and the least rumination was observed in spring (P≤0.05). Rumination behavior was reverse of grazing behavior. Consumptive behaviors of sheep may reduce their rumination behavior (Kronberg et al., 1997). Similarly, low rumination behaviors were reported in rainy seasons and high rumination was reported in dry seasons for cattle, sheep and goats (Ouedraogo-Kone et al., 2006; Sanon et al., 2007). However in present study, seasonal changes were found probably because of transition of behavioral frequencies to night and day hours.

Table 2. Estimation (b), standard error (SE), odds ratio (ψ) and significance levels for behavioral characteristics of the seasons

Season	Winter			Spring			Summer			Autumn[1]	P
Behavior	b	SE	ψ	b	SE	ψ	b	SE	ψ	ψ	
Grazing	0.77	0.07	2.15^{a}	0.83	0.09	2.29^{a}	-1.13	0.05	0.32^{c}	1.00^{b}	<0.0001
Rumination	-0.29	0.07	0.74^{b}	-0.69	0.10	0.50^{c}	0.09	0.06	1.09^{a}	1.00^{a}	<0.0001
Resting	-1.02	0.12	0.36^{d}	-0.66	0.14	0.51^{c}	0.78	0.05	2.18^{a}	1.00^{b}	<0.0001
Locomotion	0.23	0.11	1.25^{a}	-0.20	0.18	0.81^{b}	0.08	0.14	1.08^{b}	1.00^{b}	0.0211

[1]In autumn b=0.00 and SE=0.00. The differences indicated with different letter in the same line for seasonal behaviors are significant (P≤0.05).

As it was in grazing and rumination behaviors, locomotion behaviors of Gökçeada sheep were also significantly different in all seasons (Table 2). The sheep were mostly observed in resting position during the day hours of in the months of summer and rested the least in winter months (P≤0.05). Locomotion behavior significantly differentiated in winter along with high frequencies (P≤0.05). Evangelou et al. (2014) reported that the standing behavior of the sheep in winter, spring and autumn recorded as 7.4%, 16.9% and 43.8%, respectively. The resting behaviors of the sheep in rainy, post-rainy and dry seasons were reported as 9.8%, 16.4% and 15.3%, respectively (Sanon et al., 2007).

Grazing behavior exhibited a fluctuating trend with day hours in winter and spring months (Figure 2). The grazing behavior with increased frequencies during the morning and evening hours in the months of summer and autumn decreased to the lowest levels between the hours 10:00-16:00. Such a trend was more distinctive in summer as compared to autumn. Similar findings on grazing rhythms through the day hours were also reported by Dudzinski and Arnold (1979) for different sheep races. It was also reported that the grazing and resting behaviors of the sheep have been found with changes in day light (Haris and O'Connor, 1980) and sheep usually grazed at night, early in the morning

and evening hours during the summer months in long as well as hot day hours (Ferreira et al., 2013).

It was observed in this study that sheep demonstrated rumination behavior in the months of summer and autumn during noon hours in which they didn't graze (Figure 2). In summer and autumn with low grazing and high resting frequencies, the changes in resting behavior throughout the day were reverse of grazing and parallel to rumination behavior as expected.

The sheep started to rest after 08:00 in summer and after 09:00-10:00 in autumn. Sheep demonstrated different resting behavior in spring and winter seasons from the other seasons. It was reported in a study including different herbivores that all animals spent mid-day with resting (Ferreira et al., 2013).

The locomotion behavior with relatively lower frequencies in this study demonstrated quite fluctuating trend throughout the day.

CONCLUSIONS

Behavioral rhythms of Gökçeada sheep were significantly found different in each season. Therefore, the seasonal changes in behavior frequencies and the changes in nutrient contents of rangeland vegetation throughout the year should critically be assessed. Gökçeada sheep minimized their grazing frequencies during the day hours in the months of summer. During this season, an increase was rather observed in grazing frequencies during morning and evening hours. They spent the rest of the day with resting and rumination. On the other hand, sheep spent majority of the day with grazing in winter and spring.

It was also observed in this study that Gökçeada sheep, raised freely throughout the year and they, were able to self-sustain over unfertile pastures with dominant prickly burnet cover with worthless nutrient contents.

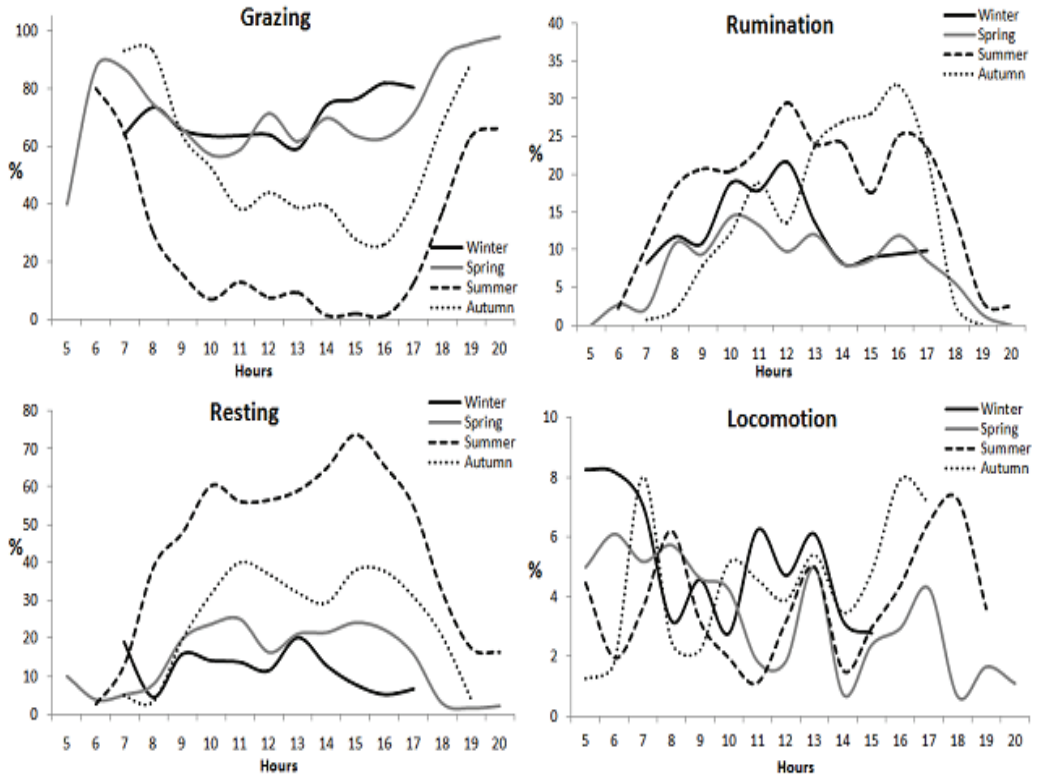

Figure 2. Day-hour behavior rhythms of Gökçeada sheep, %

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