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Production Potential of a Natural Pasture Compared to a Wheat Pasture, Both Grazed by Lactating Goats under Mediterranean Climate Conditions

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Abstract: The aim of this study was to extend the grazing period using a wheat pasture that produced high quality forage, and to compare the productivity of natural and wheat pastures for grazing goats during a 3-year period (2003-2005) in a Mediterranean zone of Turkey. Twelve 3-4-year-old Saanen goats were allocated to each pasture (10 goats ha^{-1}). Pastures were grazed for 2 months (May and June) in 2003 and for 3 months (April, May, and June) in 2004 and 2005. In the study, pasture yield and hay intake, crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF) content of the hay, and milk yield and milk fat percentage were determined. Pasture yield was significantly affected by pasture type ($P < 0.001$) for each year and the wheat pasture (5.34-6.51 t ha^{-1}) yielded approximately 3.5-fold more hay than the natural pasture (1.48-1.88 t ha^{-1}). Goats in the wheat pasture consumed significantly more forage in 2003 ($P = 0.015$), 2004 ($P < 0.001$), and 2005 ($P < 0.001$). Average hay intake in the wheat pasture ranged between 2.32 ± 0.27 and 2.53 ± 0.27 kg d^{-1} in 2003, 1.42 ± 0.26 and 3.35 ± 0.26 kg d^{-1} in 2004, and 2.69 ± 0.25 and 3.33 ± 0.25 kg d^{-1} in 2005, whereas it ranged between 1.54 ± 0.27 and 1.95 ± 0.27 kg d^{-1} in 2003, 0.79 ± 0.26 and 1.79 ± 0.26 kg d^{-1} in 2004, and 0.81 ± 0.25 and 1.60 ± 0.25 kg d^{-1} in 2005 in the natural pasture. Most of the interactions between pasture type and grazing month were statistically significant in terms of the CP, NDF, and ADF content of the pasture samples. In the first months CP content of the hay in the wheat pasture was higher than in the natural pasture, whereas this was reversed, especially in June. In addition, NDF and ADF content were not similar to CP content. In general, daily milk yield of the goats grazed on the wheat pasture was higher than that of those grazed on the natural pasture throughout the study. Milk yield was consistent with hay intake and milk fat percentage was inversely related to milk yield during the study. It was concluded that the wheat pasture had better potential for supplying nutrients to lactating dairy goats than did the natural pasture in spring.

Key Words: Pasture type, pasture yield, hay intake, milk yield, goat

Akdeniz İklim Kuşağında Süt Keçileri Tarafından Otlatılan Doğal ve Buğday Meralarının Üretim Güçleri

Özet: Üç yıl süreyle (2003-2005) yürütülen bu araştırmanın amacı Akdeniz iklim kuşağında buğday merası ile otlatma dönemini uzatabilmek ve doğal ve buğday merasının üretim gücünü değerlendirmektir. Denemede her bir mera tipinde 3-4 yaşlı 12 adet Saanen keçisi (10 keçi ha^{-1}) kullanılmıştır. Mera tipleri 2003 yılında 2 ay (Mayıs ve Haziran), diğer deneme yıllarında ise 3 ay (Nisan, Mayıs, Haziran) süreyle otlatılmıştır. Çalışmada meranın kuru ot verimi, yenen ot miktarı, otun ham protein (HP) oranı, nötr çözücülerde çözünmeyen lifler (NDF), asit çözücülerde çözünmeyen lifler (ADF) oranları, süt verimi ve süt yağ oranı incelenmiştir. Meranın ot verimi her yıl mera tiplerinden önemli derecede etkilenmiş ($P < 0.001$) ve buğday merasının (5.34-6.51 t ha^{-1}) ot verimi, doğal meranınkinden (1.48-1.88 t ha^{-1}) yaklaşık 3.5 kat daha fazla olmuştur. Buğday merasında yenen ot miktarı 2003 ($P = 0.015$), 2004 ($P < 0.001$) ve 2005 ($P < 0.001$) yıllarında önemli derecede daha yüksek gerçekleşmiştir. Ortalama yenen ot miktarı buğday merasında 2003, 2004 ve 2005 yıllarında sırasıyla 2.32 ± 0.27 - 2.53 ± 0.27 kg $gün^{-1}$, 1.42 ± 0.26 - 3.35 ± 0.26 kg $gün^{-1}$, 2.69 ± 0.25 - 3.33 ± 0.25 kg $gün^{-1}$ arasında, doğal merada ise yıllara göre aynı sırayla 1.54 ± 0.27 - 1.95 ± 0.27 kg $gün^{-1}$, 0.79 ± 0.26 - 1.79 ± 0.26 kg $gün^{-1}$, 0.81 ± 0.25 - 1.60 ± 0.25 kg $gün^{-1}$ arasında tespit edilmiştir. Otun HP, NDF ve ADF oranları bakımından mera tipleri ve otlatma ayları arasındaki etkileşimler genellikle önemli bulunmuştur. Otlatmanın ilk ayında otun HP oranı buğday merasında doğal meradan daha yüksek olmakla beraber, bu ilişki özellikle Haziran ayında tam tersi yönde gerçekleşmiştir. Bunun yanında NDF ve ADF oranlarına ait sonuçlar ise HP oranına ait sonuçların tam tersidir. Genel olarak buğday merasında otlayan keçilerin günlük süt verimleri deneme süresince doğal meraya göre önemli derecede daha yüksek olmuştur. Süt veriminin yenen ot miktarı ile doğru, süt yağı oranının süt verimi ile ters yönde değiştiği belirlenmiştir. Araştırmadan elde edilen bulgulara göre, buğday merasının sağmal keçiler için ilkbaharda doğal meradan daha yüksek bir besleme gücüne sahip olduğu söylenebilir.

Anahtar Sözcükler: Mera tipi, Mera verimi, yenen ot miktarı, süt verimi, keçi

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Introduction

Better utilization of pastures, which are the cheapest source of feed, is important to profitable livestock production. Because pastures do not produce enough good quality forage throughout the year, alternative feed sources are suggested. Different natural and artificial pastures, therefore, are important. For example, pastures that consist of evergreen shrubs in a Mediterranean zone are indispensable, especially for goats, throughout the year. In particular, when herbaceous plants are dried, the green phytomass of these shrubs is used by ruminants (Olea et al., 1994); however, the feed quality of shrubs is not as high as that of herbaceous species (Papanastasis et al., 2004). Moreover, pasture types that include herbaceous species (i.e. steppe, forest gap, and coastal) are very common. Cool season species are common in the herbaceous layer of natural pastures located in the northern Mediterranean zone. They are generally able to produce an adequate quantity of quality forage in the spring and autumn, depending on precipitation.

Small grain cereals can be valuable forage for domestic animals (Watson et al., 1993). Similarly, small grain pastures are used as a forage source in the region. Winter hardy cereals, such as wheat, start to grow fairly early in spring due to their tolerance to cold, thereby reaching grazing maturity early. When cultivated in autumn, wheat pastures are potentially important due to earlier and faster growth than natural pastures. Moreover, wheat pastures reach grazing maturity in spring, which is earlier than natural pastures, enabling prompt grazing. In addition, wheat pastures yield forage with a crude protein content of up to 20%-30% in soft tissue during the immature period, especially in the early growth stage, which is consumed voluntarily by animals (Shroyer et al., 1993; Torell et al., 1999a). Winter feeding is difficult due to inadequate food supply; therefore, animals should be sent to pasture in early spring. Although sheep and goats benefit from pasture all year, early grazing is crucial for preventing pasture deterioration (Gökkuş and Koç, 2001). Wheat pastures might be an alternative for alleviating early and year-round grazing pressure. At the same time, winter wheat pastures generally provide more live weight than dormant native pastures (Hersom et al., 2004).

The chemical composition, digestibility, and voluntary intake levels of forage are related to plant development stage (Holechek et al., 1989; Kirilov, 2001; Raghavendra et al., 2001). Pasture hay has a high feed value at the beginning of grazing, then decreases rapidly, especially in the summer dry season (Bakoğlu et al., 1999). As such, wheat or native pastures with annual plants could provide enough hay for grazing animals during 1 or 2 months in the spring.

Maquis vegetation is widespread in the Mediterranean zone where goat production is a common livestock enterprise. As goats utilize these woody plants best (Meurer and Steinbach, 1986; Shimoda and Hayashi, 1996; Orodho, 1999), uncontrolled grazing and climatic conditions (long lasting dry summers) have caused these perennial herbaceous species to be replaced by annuals in shrublands. Annual plants generally have shorter growing periods and lower yields (Gökkuş and Koç, 2001); therefore, the quantity of forage supplied by these types of plants is limited. Grain pastures are promising forage alternatives for providing nutrients for dairy goats. Thus, the objectives of the present study were to determine the production potential of natural and wheat pastures, and to estimate their effects on milk yield and quality in lactating goats.

Materials and Methods

This study was conducted between 2003 and 2005 in Üvecik village, located 45 km from Çanakkale in western Anatolia, Turkey. Çanakkale has a typical Mediterranean climate (Türkeş et al., 2002). Annual precipitation in Çanakkale was 509.1, 505.5, and 729.4 mm, with a mean temperature of 14.7, 15.3, and 15.1 °C in 2003, 2004, and 2005, respectively. The pasture soils had a sandy-clay-loam texture and contained 1.86% organic matter, 23.5% $CaCO_3$, 1.37 t of K_2O ha^{-1}, and 10.3 t of P_2O_5 ha^{-1}, and had a pH of 8.1 (Ekinci et al., 2004).

The study was conducted in natural and wheat pastures. The natural pasture consisted of open shrubby vegetation (pink rockrose, *Cistus creticus*, was the most prevalent). Among the herbaceous species, annual species such as goatgrass (*Aegilops ovata*), animated oat (*Avena sterilis*), bulbous barley (*Hordeum bulbosum*) and *Bupleurum flavum* were the most common. The wheat pasture was established in autumn (Oct. 15-20) each year of the study. Gönen cultivar seeds were sown with a seeder and rows were spaced 17.5 cm apart on the plowed field. Each pasture type had 12 head of 3-4-year-old lactating goats, with a stoking density of 10 goats ha^{-1}.

Thus, each pasture type was 1.2 ha (100 × 120 m) and the total experimental area was 2.4 ha. The plots were fenced with barbed wire. Goats with twin kids whose kidding dates and milk yields were similar were selected each year. The goats used in the study gave birth between January 15 and February 1. Average live weight of the animals at the beginning of the grazing period in the natural and wheat pastures in 2003, 2004, and 2005 was 53.53 ± 2.15 and 51.03 ± 2.06 kg, 55.29 ± 2.33 and 55.27 ± 2.29 kg, and 55.39 ± 2.36 and 52.05 ± 1.69 kg, respectively. Paddocks were built next to the pastures to provide water, supplemental feed, and shadow for the goats. Gates between the paddocks and grazing plots were always open; therefore the goats grazed freely and continuously.

Pastures were grazed in April, May, and June in each year; however, grazing in 2003 started 1 month later due to re-establishment of the wheat pasture as a result of poor stand. As such, grazing was conducted for only 2 months (May and June) in 2003. Before grazing began, 15 cages (1 m × 1 m × 1 m) were placed in 5 rows in each pasture. An area of 1 m^2 inside and outside of the cages was harvested to ground level with blade shears. After cutting the pasture, cages were replaced about 1 m away from their original placement. Thus, pasture growth and intake were determined at the beginning of each grazing period and at the end of each month. Yield in the cage was referred to as pasture yield, whereas the difference between the yields inside and outside each cage was considered the quantity of hay grazed (Brown, 1957). Hay production in the pastures was determined monthly; therefore, monthly change in hay yield and total yield were evaluated together. Monthly pasture yield was determined by subtracting the ungrazed plant biomass (yield outside the cage) in the previous month from the yield inside the cage. In this way, pasture yield within a month of grazing was calculated. Change in pasture yield throughout the grazing period was determined based on monthly pasture yield in consecutive months. To determine hay yield, hay samples taken from the pastures were air-dried, then dried at 60 °C and weighed (Mooso and Wedin, 1990). Total yield was calculated as follows:

$$\text{Total Yield} = Y_{ic1} + (Y_{ic2} - Y_{oc1}) + (Y_{ic3} - Y_{oc2})$$

where, Y_{ic1}, Y_{ic2}, Y_{ic3} are the yield inside the cage at the end of the 1st, 2nd, and 3rd grazing month, respectively, and Y_{oc1} and Y_{oc2} are the yield outside the cage at the end of the 1st and 2nd grazing month.

In addition to pasture, concentrate feed (912 g of DM kg^{-1}, 193.3 g of CP kg^{-1} of DM, and 2.78 Mcal of ME kg^{-1} of DM) was offered on a group basis at the level of 0.5 $kg \cdot d^{-1} \cdot animal^{-1}$ throughout the study for supplementary purposes. Live weight of the animals was measured every 2 weeks. Milk samples were collected weekly on yield control days. Milk samples were analyzed via an auto analyzer (MILKANA® Milk Analyzer).

Dry matter (DM) and crude protein (CP) content of pasture samples and supplementary feeds were determined according to AOAC (1990). Neutral detergent fiber (NDF) was analyzed as described by Van Soest et al. (1991) and acid detergent fiber (ADF) content of the feed samples was determined according to the method of Goering and Van Soest (1970).

Repeated measurement analysis of variance was used to determine the effect of pasture type (natural or wheat), grazing month (April, May, and June), and pasture × grazing month interaction separately for each year. The statistical model used was:

$$Y_{ijk} = \mu + \alpha_i + \Pi_{k(i)} + \beta_j + \alpha\beta_{ij} + \beta\Pi_{jk(i)} + \varepsilon_{m(ijk)} \qquad (1)$$

where, Y_{ijk} is the observed value for pasture yield, hay intake, CP, NDF, and ADF content, and milk yield and milk fat, μ is the overall mean population, α_i is the effect of i^{th} pasture type (i = 1,2), β_j is the effect of j^{th} grazing month (j = 1,2,3), $\alpha\beta_{ij}$ is the pasture type × grazing month interaction, $\Pi_{k(i)}$ is the random effect of grazing month I in i^{th} pasture type, $\beta\Pi_{jk(i)}$ is the i effect of interaction between grazing month and experiment unit within pasture type, and $\varepsilon_{m(ijk)}$ is the random error term. Tukey's multiple comparison test was used for post hoc analysis (Winer et al., 1991). All statistical analyses were performed using the SAS v.6.07 statistical package program (SAS Institute Inc., 1999, User's Guide, Cary, NC, USA).

Results

Monthly yield change

Pastures yields based on pasture type differed significantly each year ($P < 0.001$). The wheat pasture yield (5.34-6.51 t ha^{-1}) was almost 3.5-fold greater than that of the natural pasture yield (1.48-1.88 t ha^{-1}). Hay yield of the pastures during the grazing period followed a different pattern based on pasture type. The natural pasture yield gradually decreased from the beginning of grazing in all 3 years, whereas the wheat pasture yield was generally higher in April and May, but was significantly lower at the beginning of grazing and in June each year ($P < 0.001$). The pastures showed yield losses in June due to dried leaves and stem senescence (Table 1).

In general, yield of the wheat pasture was significantly higher than that of the natural pasture in the grazing months each year of the study ($P < 0.001$); however, yields of both pastures did not significantly differ from the beginning of grazing. In addition, the natural pasture yielded more hay in June 2003 (0.03 ± 0.03 t ha^{-1} vs. -1.45 ± 0.03 t ha^{-1}), but no difference between the natural and the wheat pastures was found in 2005 (–0.08 ± 0.04 and –0.04 ± 0.04 t ha^{-1}, respectively).

Hay Consumption

Daily consumption by the goats is presented in Table 2. Goats grazing on the wheat pasture consumed significantly more hay than those grazing on the natural pasture each year of the study ($P = 0.015$ in 2003, and $P < 0.001$ in 2004 and 2005). Daily hay consumption by the goats was consistent with pasture yield. The highest consumption in the wheat pasture occurred in May all 3 years (2.53 ± 0.27 kg d^{-1}, 3.35 ± 0.26 kg d^{-1}, and 3.33 ± 0.25 kg d^{-1}, respectively), whereas daily hay consumption in the natural pasture was generally highest in the first grazing month (1.95 ± 0.27 kg d^{-1} in May 2003, 1.79 ± 0.26 kg d^{-1} in April 2004, and 1.60 ± 0.25 kg d^{-1} in May 2005). The lowest level of hay consumption by the goats in both pastures was generally associated with advancing plant maturity.

CP Content

Crude protein (CP) content of hay changed significantly, in terms of grazing months, each year of the study ($P < 0.001$). Differences in CP content between the pastures in 2003 and 2004 were significant ($P = 0.001$ and $P = 0.001$), but not in 2005 ($P = 0.196$). Pasture × grazing interaction all years was significant ($P < 0.001$). In both wheat and natural pastures, CP content of hay decreased with advancing plant maturity (from 14.83% ± 0.58%-16.07% ± 0.51% to 4.30% ± 0.24%-5.77% ± 0.36% for the wheat pasture [a decrease of about 67%] and from 11.10% ± 0.58%-12.00% ± 0.34% to 5.33% ± 0.41%-7.23% ± 0.36% for the natural pasture [a decrease of about 50%]) (Table 3).

Table 1. Monthly changes in pasture yields (t ha^{-1}).

Year	Pasture Type	Starting	April	May	June	Total
2003	NP	1.52 b	_	0.33 c	0.03 c	1.88
	WP	1.71 b		6.25 a	–1.45 d	6.51
	Mean	1.62 B		3.29 A	–0.71 C	4.20
	SE	0.17		0.17	0.03	
	Significance: $P_p < 0.001$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.001$					
2004	NP	0.68 b	0.54 b	0.44 b	–0.18 c	1.48
	WP	0.65 b	2.38 a	2.46 a	0.84 b	6.33
	Mean	0.66 B	1.46 A	1.45 A	0.33 B	3.90
	SE	0.15	0.15	0.15	0.15	
	Significance: $P_p < 0.001$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.001$					
2005	NP	0.67 cd	0.54 d	0.36 de	–0.08 e	1.49
	WP	1.03 c	2.58 a	1.77 b	–0.04 e	5.34
	Mean	0.85 B	1.56 A	1.06 B	–0.06 C	3.41
	SE	0.14	0.14	0.14	0.04	
	Significance: $P_p < 0.001$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.001$					

NP: Natural pasture; WP: wheat pasture; $_p$: pasture; $_{gm}$: grazing month.
Lowercase letters indicate significance between interactions; $P < 0.05$.
Upper case letters indicate significance between grazing months; $P < 0.05$.

Table 2. Monthly changes in hay consumption (kg d^{-1}).

Year	Pasture Type	April	May	June
2003	NP	_	1.95	1.54
	WP		2.53	2.32
	Mean	_	2.24	1.93
	SE		0.27	0.27
	Significance: $P_p = 0.015$, $P_{gm} = 0.254$, $P_{p \times gm} = 0.709$			
2004	NP	1.79 b	1.49 bc	0.79 c
	WP	2.69 a	3.35 a	1.42 bc
	Mean	2.24 A	2.42 A	1.10 B
	SE	0.26	0.26	0.26
	Significance: $P_p < 0.001$, $P_{gm} < 0.001$, $P_{p \times gm} = 0.046$			
2005	NP	1.18	1.60	0.81
	WP	2.69	3.33	2.91
	Mean	1.94 B	2.46 A	1.86 B
	SE	0.25	0.25	0.25
	Significance: $P_p < 0.001$, $P_{gm} = 0.036$, $P_{p \times gm} = 0.502$			

NP: Natural pasture; WP: wheat pasture; $_p$: pasture; $_{gm}$: grazing month.
Lowercase letters indicate significance between interactions; P < 0.05.
Upper case letters indicate significance between grazing months; P < 0.05.

Table 3. Monthly changes in CP content (%).

Year	Pasture Type	Starting	April	May	June
2003	NP	12.00 b	_	7.03 d	5.80 e
	WP	15.00 a		8.70 c	4.30 f
	Mean	13.50 A	_	7.87 B	5.05 B
	SE	0.34		0.24	0.24
	Significance: $P_p = 0.001$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.001$				
2004	NP	11.10 c	11.06 c	6.18 e	5.33 ef
	WP	14.83 a	12.59 b	8.18 d	4.94 f
	Mean	12.97 A	11.83 B	7.18 C	5.14 D
	SE	0.58	0.41	0.41	0.41
	Significance: $P_p = 0.001$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.001$				
2005	NP	11.88 b	8.96 c	8.80 c	7.23 d
	WP	16.07 a	11.48 b	6.90 d	5.77 e
	Mean	13.98 A	10.22 B	7.85 C	6.50 D
	SE	0.51	0.36	0.36	0.36
	Significance: $P_p = 0.196$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.001$				

NP: Natural pasture; WP: wheat pasture; $_p$: pasture; $_{gm}$: grazing month.
Lowercase letters indicate significance between interactions; P < 0.05.
Upper caser letters indicate significance between grazing months; P < 0.05.

NDF and ADF Content

Changes in NDF and ADF content of the pastures were similar with respect to pasture type and grazing months (Tables 4 and 5). Differences between grazing months all 3 years were significant in terms of these characters ($P < 0.001$). In general, differences between pasture types were not significant, except for ADF content in 2003. Mean NDF content at the beginning of grazing ranged from 51.14% ± 0.68% to 51.93% ± 0.61%, whereas at the end of the grazing it increased by about 15%, ranging between 58.04% ± 0.48% and 59.97% ± 0.48%. Mean ADF content at the beginning of grazing was between 39.56% ± 0.38% and 41.72% ± 0.36%, whereas mean ADF content at the end of grazing was between 46.05% ± 0.36% and 47.83% ± 0.27%, an average increase about 16%.

Milk Yield

Differences in daily milk yield of the goats, according to pasture type, were significant in 2005 ($P = 0.014$), but not in 2003 or 2004 ($P = 0.130$ and $P = 0.068$, respectively). In addition, both grazing month and pasture × grazing month interaction were significant throughout the study (Table 6). In general, milk yield of the goats that grazed in the wheat pasture was higher than that of the goats that grazed on the natural pasture, each year of the study and for all grazing months. Daily milk yield was high in the first grazing month (April or May) (2319.7 ± 73.1 ml $head^{-1}$-2642.5 ± 103.5 ml $head^{-1}$) and then declined with advancing plant maturity. Milk yield of the goats that grazed on the natural and wheat pastures in June (1307.2 ± 105.8-1719.8 ± 106.7 ml $head^{-1}$ and 1619.3 ± 102.2-2074.9 ± 140.2 ml $head^{-1}$, respectively) was significantly lower than in other months (Table 6).

Milk Fat

Generally, the effects of pasture type and grazing month on the percentage of milk fat each year of the study were not statistically significant, except for the percentage of milk fat of the goats that grazed on the wheat pasture in 2004. While mean daily milk yield decreased, the percentage of milk fat increased in the last grazing month in 2004. Pasture × grazing month interaction was significant only in 2005 ($P = 0.003$). In this year, the percentage of milk fat did not differ significantly in the natural pasture, but increased significantly in the wheat pasture in June (Table 7).

Table 4. Monthly changes in NDF content (%).

Year	Pasture Type	Starting	April	May	June
2003	NP	50.89 c	_	59.30 ab	59.92 a
	WP	52.96 c		57.66 b	58.20 b
	Mean	51.93 B	_	58.48 A	59.06 A
	SE	0.86		0.61	0.61
	Significance: $P_p = 0.453$, $P_{gm} < 0.001$, $P_{p \times gm} = 0.028$				
2004	NP	53.05 de	51.31 ef	60.71 ab	58.83 b
	WP	49.23 f	53.72 d	55.78 c	61.10 a
	Mean	51.14 D	52.52 C	58.25 B	59.97 A
	SE	0.96	0.68	0.68	0.68
	Significance: $P_p = 0.061$, $P_{gm} < 0.001$, $P_{p \times gm} = 0.001$				
2005	NP	52.92 b	53.75 b	58.56 a	58.08 a
	WP	49.59 c	54.28 b	58.05 a	58.00 a
	Mean	51.26 C	54.02 B	58.31 A	58.04 A
	SE	0.96	0.68	0.68	0.68
	Significance: $P_p = 0.118$, $P_{gm} < 0.001$, $P_{p \times gm} = 0.138$				

NP: Natural pasture; WP: wheat pasture; $_p$: pasture; $_{gm}$: grazing month.
Lowercase letters indicate significance between interactions; $P < 0.05$.
Upper case letters indicate significance between grazing months; $P < 0.05$.

Table 5. Monthly changes in ADF content (%).

Year	Pasture Type	Starting	April	May	June
2003	NP	41.57 e	_	46.53 b	47.91 a
	WP	41.88 e		45.17 c	45.72 bc
	Mean	41.72 C	_	45.85 B	46.82 A
	SE	0.52		0.36	0.36
	Significance: $P_p = 0.003$, $P_{gm} < 0.001$, $P_{p \times gm} = 0.021$				
2004	NP	40.75 d	40.35 d	47.17 b	47.07 b
	WP	38.37 e	43.64 c	44.12 c	48.60 a
	Mean	39.56 D	42.00 C	45.65 B	47.83 A
	SE	0.54	0.38	0.38	0.38
	Significance: $P_p = 0.606$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.001$				
2005	NP	40.64 e	42.06 de	45.23 ab	45.98 ac
	WP	38.60 f	42.99 cd	43.88 b	46.13 a
	Mean	39.62 D	42.53 C	44.56 B	46.05 A
	SE	0.71	0.50	0.50	0.50
	Significance: $P_p = 0.336$, $P_{gm} < 0.001$, $P_{p \times gm} = 0.043$				

NP: Natural pasture; WP: wheat pasture; $_p$: pasture; $_{gm}$: grazing month.
Lowercase letters indicate significance between interactions; $P < 0.05$.
Upper case letters indicate significance between grazing months; $P < 0.05$.

Table 6. Monthly changes in daily milk yield (ml head^{-1}).

Year	Pasture Type	April	May	June
2003	NP	_	2243.9 b	1719.8 c
	WP		2561.9 a	1869.9 c
	Mean	_	2402.9 A	1794.8 B
	SE		109.2	106.7
	Significance: $P_p = 0.130$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.013$			
2004	NP	2263.8 a	1916.9 b	1307.2 d
	WP	2375.6 a	2275.8 a	1619.3 c
	Mean	2319.7 A	2096.4 B	1463.2 C
	SE	103.4	103.4	102.2
	Significance: $P_p = 0.068$, $P_{gm} < 0.001$, $P_{p \times gm} = 0.028$			
2005	NP	2310.8 b	2082.2 c	1715.4 c
	WP	2974.2 a	2601.5 b	2074.9 cd
	Mean	2642.5 A	2341.8 B	1895.0 C
	SE	146.4	140.2	140.2
	Significance: $P_p = 0.014$, $P_{gm} < 0.001$, $P_{p \times gm} < 0.001$			

NP: Natural pasture; WP: wheat pasture; $_p$: pasture; $_{gm}$: grazing month.
Lowercase letters indicate significance between interactions; $P < 0.05$.
Upper case letters indicate significance between grazing months; $P < 0.05$.

Table 7. Monthly changes in daily milk fat (%).

Year	Pasture Type	April	May	June
2003	NP	–	3.57	3.60
	WP		3.58	3.56
	Mean	–	3.58	3.58
	SE		0.02	0.02
	Significance: $P_p = 0.541$, $P_{gm} = 0.531$, $P_{p \times gm} = 0.146$			
2004	NP	2.92	2.88	3.01
	WP	3.23	3.01	3.37
	Mean	3.08 AB	2.95 B	3.20 A
	SE	0.11	0.11	0.11
	Significance: $P_p = 0.078$, $P_{gm} = 0.003$, $P_{p \times gm} = 0.259$			
2005	NP	3.07 ab	3.03 ab	2.98 ab
	WP	2.90 b	2.95 b	3.14 a
	Mean	2.99	3.00	3.06
	SE	0.08	0.07	0.07
	Significance: $P_p = 0.731$, $P_{gm} = 0.219$, $P_{p \times gm} = 0.003$			

NP: Natural pasture; WP: wheat pasture; $_p$: pasture; $_{gm}$: grazing month.
Lowercase letters indicate significance between interactions; $P < 0.05$.
Upper case letters indicate significance between grazing months; $P < 0.05$.

Discussion

In soils with adequate moisture, wheat grows rapidly and produces a large quantity of green mass in early spring, as it is a cold-resistant plant (Akkaya, 1994). Yet, most herbaceous plants in natural pastures are annuals (*Aegilops* spp., *Avena* spp., *Hordeum* spp., *Medicago* spp., and *Trifolium* spp.) with low yield capacity. Moreover, the annual production potential of shrubs like *Cistus creticus,* which are present in the vegetation, is lower than that of wheat; therefore, the yield of the wheat pasture was higher than that of the natural pasture all 3 years of the study.

Monthly and total pasture yield the first year of the study were numerically higher than the other years, indicating that the plants had an opportunity for better growth due to grazing beginning later (Table 1). The highest yield in the wheat pasture was observed in April, when the air temperature rose slightly, but soil moisture was not lost. The highest pasture yield was obtained in April 2004 and 2005, and May 2003, prior to the start of grazing. Each year of the study temperature and evaporation increased, whereas rainfall decreased in the study area during May. This slowed vegetative development and stimulated generative development in the plants (Landsberg, 1977). Plants in both the natural and wheat pastures became dry in June due to the prevailing summer droughts; therefore, there was no hay production in either pasture in June, even yield losses were observed due to senescence and the dropping off of dry plant parts. Species in natural pastures, which are mainly annual plants, develop faster at the beginning of the growth season and then their development gradually decreases (Gökkuş and Koç, 2001); accordingly, the yield of the natural pasture was high at the beginning of the grazing, and then gradually decreased.

Consumption of feedstuffs is largely influenced by their chemical composition and, hence, digestibility (Van Soest, 1994). Changes in these parameters throughout the vegetation cycle explain fluctuations in consumption. Wheat pastures provide good quality feed with high digestibility and acceptability (Shroyer et al., 1993; Torell et al., 1999b). Moreover, there is a linear correlation between the water content of hay and daily consumption. Forages with high water content are preferred for consumption by animals (Holechek et al., 2004). In the present study, the changes in average consumption in both pastures throughout the grazing months were in accord with the preceding statements. The reduction in consumption observed during the June grazing period each year of the study can be explained by the reduction in available pasture, the decrease in both CP and water content, and the increase in NDF and ADF content of the plants (Tables 4 and 5). Buxton and Mertens (1995) reported that reduction in pasture quality because of maturity, especially in *Poaceae*, is associated with lower digestibility, which can cause problems in the choice and/or intake of feedstuffs by animals.

CP content of hay decreased during the grazing period, whereas NDF and ADF content increased. As plants grow to the cell maturation stage, their cell walls thicken with increasing structural carbohydrates (i.e. cellulose, hemicellulose, and lignin). In contrast, the constituents of cytoplasm decrease and physiological activity slows down (Mohr and Schopfer, 1995). As enzyme activity in mature cells decreases, the growth rate and CP content decrease; thus, many researchers report that CP content decreases with plant growth, whereas the content of fibrous compounds, such as NDF and ADF, increases (Popovic et al., 2001; Jefferson et al., 2004; Jeranyama and Garcia, 2004; Beck et al., 2007). In the present study, CP content decreased after May, a time of rapid plant maturation, whereas NDF and ADF content increased. CP supply is very critical and may limit the performance of ruminants under certain conditions, as rumen microorganisms require N for microbial protein synthesis, which is primarily supplied by CP in feed (Mertens, 1994). Plants in the wheat pasture had higher CP content than those in the natural pasture, as the plants in the wheat pasture produced softer and less fibrous hay during the jointing stage; however, the natural pasture produced hay with higher CP content than the wheat pasture did during the last month of grazing.

Changes in the nutritional potential of natural resources throughout the year affect production systems that are dependent upon these resources. Akpa et al. (2001) reported that goats give birth in the rainy season when the yield of grazable plant biomass increases, resulting in the production of more milk. They stated that the birth season is an important factor determining lactation curve parameters. Cabiddu et al. (1999) reported that the nutritional potential and changes throughout the year in natural grazing areas in the Mediterranean region provide enough potential for local genotypes in most areas and reasonable milk yield under non-supplemented feeding.

Studies of Saanen goats demonstrate that average milk yield is 1.8 kg day^{-1} and can increase up to 2 kg day^{-1} during early lactation (Pala and Savaş, 2005); therefore, early spring is a crucial period for goat husbandry, as the majority of kids are born between January and March, and a number of nutritional-based problems occur. Early and heavy grazing of natural pastures during this period creates problems related to inadequate provision of nutrients and the sustainability of natural resources; therefore, the development of forage with a similar nutritional potential to natural pastures offers a great opportunity, beyond economic benefits, in terms of the sustainability of natural resources. The climatologic conditions of the study region make wheat pastures an important alternative in this sense. The interest in wheat pastures has grown in beef cattle production systems due to its fast-growing nature, CP content, and high digestibility (Mader et al., 1983; Vogel et al., 1989; Horn et al., 2005).

In the present study milk yield data showed that the wheat pasture had great potential to support lactation in early spring. In this period high nutritive value ensures more consumption of nutrients (Paterson et al., 1994); however, there is no study of the potential utilization of wheat pastures for the nutrition of lactating goats. On the other hand, goats are reported to reduce their dry matter consumption more rapidly than cattle and sheep when pasture yield is below 1000 kg of DM ha^{-1} (AFRC, 1998). In the present study the wheat pasture had a higher pasture yield (Table 1) and the goat grazing parameters observed in the wheat pasture (Table 2) were consistent with the AFRC report (1998). Grazing under semi-arid conditions increases maintenance requirements by 25%. This increase can reach as high as 75% in mountainous areas and poor pastures (NRC, 1981); therefore, the provision of homogenous feed in wheat pastures, in addition to high yield, can result in less energy expenditure for food seeking. Milk yield of the goats in the wheat pasture was higher during all grazing months all 3 years of the study, and differences were only significant in 2005 ($P = 0.014$, Table 6). Progression of lactation, and changes in pasture yield and chemical compositions of vegetation were the 2 most important reasons milk yield decreased in both groups; however, the trends, in terms of persistence, especially in 2004, were important for determining the potential of the wheat pasture. In 2004 the observed decrease in milk yield during April and May was 15% in the natural pasture and 4.2% in the wheat pasture. The drop in milk yield in May and June was 31% in the natural pasture and 28% in the wheat pasture. In this regard, the natural pasture could be regarded to have been a crucial and continuous nutrient source, in spite of its low yield and quality. The natural pasture had a higher nutritional value in June (higher CP content and generally lower NDF and ADF content; Tables 3, 4, and 5). The evaluation of milk yield values in both pasture groups and the changes in milk fat in the same periods was important in the assessment of the nutritional potential of the pastures. Comparison of milk energy values based on the percentage of milk fat (GfE, 2003) demonstrated that the differences between pasture types in April, May, and June 2004 were 0.145, 0.238, and 0.262 Mcal day^{-1}, respectively, which were all in favor of the wheat pasture. Based on milk with 3% fat, the values indicated differences of 0.233, 0.366 and 0.403 kg day^{-1} between pasture types in April, May, and June 2004, respectively.

In conclusion, wheat pastures in the Mediterranean region represent an alternative feed source with satisfactory yield and quality before natural pastures are available for grazing. They can provide feed for animals for about 2 months. Natural pastures, on the other hand, produce sufficient and cheap feed for goats, especially after May, although the quality decreases afterwards; therefore, utilizing wheat pastures along with natural pastures may be needed for expanding the grazing period, as well as providing a sufficient and balanced diet.

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