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Dry Matter Yield and Grazing Capacity of Kermes Oak (*Quercus coccifera* L.) Scrublands for Pure Hair Goat (*Capra hircus* L.) Breeding in Turkey's Western Mediterranean Region

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Abstract: It is forbidden to graze goats in state forests in Turkey. Despite this ban, villagers graze their goats in state forests because certain tree and herb varieties that grow in state forests provide an important source of nutrition for goats. With the action plan, it prepared in 2008, the department of forest administration announced that goat grazing would be allowed in state forests. The prepared plan does not include any scientific information as to where and how many goats would be allowed to graze. This study has determined the green herbage and dry matter yield of kermes oak (*Quecus coccifera* L.), which constitutes a significant source of nutrition in the raising of pure hair goats, the capacity of a unit area for grazing and the number of pure hair goats that can graze per unit area. Measurements taken at 6 periods (April 15, May 15, June 15, July 15, August 15, September 15 2008) have resulted in an herbage yield of 2410.0, 4418.3, 5746.6, 6350.0, 6363.3, 6366.6 kg ha^{-1}, respectively ($p<0.05$) and a dry matter yield of 772.0, 1911.3, 3093.3, 3610.0, 3649.3, 3689.4 kg ha^{-1}, respectively ($p<0.05$). Accordingly, the number of pure hair goats that can be grazed in an area of 1 ha covered completely by Kermes Oak, for a period of 1 year, varies between 1 and 5 goats. Since June 15, is the most appropriate period for grazing, the highest number of pure hair goats that can be grazed in an area of 1 ha covered completely by kermes oak, for a period of 1 year, is 4. The number of pure hair goats that can be grazed in a unit area varies depending on the land coverage of kermes oak and the ratio of its blend with other tree varieties.

Key words: Dry matter yield, grazing capacity, kermes oak, scrubland, pure hair goat, Mediterranean region, Turkey

INTRODUCTION

Total 99% of Turkey's 21.2 million ha of forest belong to the government. Goats are not allowed inside government forests on the grounds that they cause harm to forests (GFD, 1984). General Directorate of Forest (GDF) views goat grazing in government forests as a criminal act. Despite this prohibition, 7.3 million inhabitants of forest villages graze 6.2 million (TUIK, 2008) goats in government forests. Individuals, who are caught grazing goats in government forests and are ruled to have committed a crime, receive jail sentences and fines (URL-1). Today, there are disputes and enmity in Turkey between the forestry administration and forest villagers who raise goats. Forestry officials believe that by barring goat-raising villagers from government forests, they are protecting the forests (Avci, 2005). Since villagers are obliged to raise goats in order to secure their food and income (Boyazoglu *et al*., 2005), they are unable to raise goats in a productive and sustainable manner due to forestry officials, who do not provide them with a grazing area and bar them from entering government forests (Guney and Darcan, 2005). On the other hand, government forests suffer damage due to disorderly and haphazard grazing. As a result, no one benefits from this current structure and production system. Since, forestry officials are unable to perform their duties, they are stressed and since forest villagers are unable to raise goats, they are unhappy and poor, while forest resources remain unproductive due to disorderly and haphazard grazing (Ocak *et al*., 2007).

The general directorate of forestry, in its Action plan for reducing damage caused by goats, prepared in 2008, made a number of decisions regarding goat the raising of goats. One of these decisions is to reduce the number of goats by 50% throughout Turkey, particularly in the

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Mediterranean Region where this study was conducted. 25 provinces in the Aegean and Mediterranean Regions where the raising of pure hair goats is common were selected as the implementation zone of the action plan. The total number of goats in these provinces is 3,472,000. Through actions implemented between 2008 and 2012, the number of goats is targeted to be reduced to 1,010,000. During the early months of 2008, forestry officials gathered information regarding villages and individuals engaged in goat raising as well as the number of goats. Among the decisions set 4th in the action plan, there is a very radical decision that would allow goat raising for the 1st time in certain forest zones.

However, the action plan does not provide any information as to which areas will allow goat raising and it does not include any scientific study or criteria as to why and how much the goat population needs to be reduced. Therefore, the action plan seems to approach goat raising with preconceived notions and its real goal seems to be to distance goat populations from government forests. In order to find rational and permanent solutions, it is necessary to determine through scientific studies, which trees and shrubs are used as feed in goat raising, the herbage and dry matter yield of these areas as well as their grazing capacity. When such scientific data are obtained, decisions regarding the reduction or increase of goal populations will be based not on subjective but on objective criteria.

The goat species that are most commonly raised in Turkey are the pure hair goat and the angora goat. Of these 2 species, the pure hair goat (*Capra hircus* L.) is the most commonly raised species at 96% (Ozder, 1997). There are similarities between areas where pure hair goats are raised and areas where certain tree-like plants varieties are dispersed. One of these tree-like varieties is the kermes oak (*Quercus coccifera* L.), which can be found throughout 2.4 million ha of land in Turkeys Aegean and Mediterranean Regions either by itself or mixed with other trees or shrub varieties. Pure hair goats relish eating the leaves and shoots of the kermes oak (Papachristou, 1997; Ergul, 2008). The main goal of this study is to determine the herbage and dry matter yield of kermes oak and by taking into consideration these data, to determine the number of pure hair goats that can be sustainably grazed in a unit area.

MATERIALS AND METHODS

Study area: This study was conducted at Süleyman Demirel University, Research and Implementation Forest Areas, in Isparta Province, Western Mediterranean Region of Turkey. The study area is located between 37°83'50"-37°83'31" North latitude and 30°51'72"-30°51'94" East longitude and has an elevation of 1250 m. Its slope is to the Southwest.

According to data provided by Isparta Meteorology Station, the long-term average annual rainfall is 600.4 mm. and the average air temperature is 12.1°C. During the Winter (December-March) and summer (June-September) seasons, the average air temperature ranges from 1.7-5.8 and 19.7-23.1°C and the average rainfall ranges from 90.0-100.0 and 9.6-36.6 mm, respectively. The climate of the area is characterized as semi-arid and cold winters. The soil texture is clay to wet clay, derived from conglomerates of the mesozoic period and colluvials from river or torrent bank deposits (Atalay, 2006). A range of organic matter content between 2.60-3.20% and a pH (7.5) are both considered average.

The shrub variety that shows a native range within the study area is kermes oak. Up until 7 years ago (Prior to 2002), this area was used for grazing pure hair goats, but it was, subsequently, assigned by the university to be used for research and implementation and was closed to any type of grazing. The land coverage rate of kermes oak ranges between 70 and 90% and shrub height ranges between 50 and 150 cm.

Experimental methodology: An area of three ha was selected within the university research forest with the same growth environment and site characteristics (aspect, elevation, slope, soil, etc.). Within this area, kermes oak shrubs that have spread over an area of at least 6 m^2 were identified and 30 shrubs with this characteristic were selected at random. A sampling quadron of 1×1 m was created by using wooden slats. In determining herbage yield, shoots and leaves growing in an area of 1 m^2 during a particular vegetation period were collected at each period from 30 different areas. Representative, hand-plucked forage samples (Cook, 1964) similar to those consumed by animals were collected. Samples from the study area were collected on April 15, May 15, June 15, July 15, August 15 and September 15, 2008. Green herbage samples that were collected were weighed and at each period, numerical data was obtained for samples derived from 30 kermes oak shrubs.

In order to determine the dry matter content ratios, 30 herbage samples obtained at each period were mixed into a single sample and were ground in a hummer mill with a sieve hole diameter of 3 mm. In order to determine the dry matter contents, samples were taken from this biomass. All samples were oven-dried at 105°C for 24 h

and weighed. Therefore, the dry matter contents of the samples were determined as a percentage ratio. These procedures were conducted in the laboratory separately at each period as 3 parallel and 4 recurrent analyses. The herbage yield obtained from 1 ha was multiplied with the percentage ratios of the dry matter and the dry matter quantity obtained from an area of 1 ha was calculated as kg ha^{-1}.

Statistical analyses: All data sets were subjected to repeated ANOVA measurements in order to test statistical significance across the 6 periods. The Tukey test was applied in order to test statistical differences between means (Steel and Torrie, 1980). The statistical analyses were carried out using SPSS 16.0 software for Windows. All tests were performed at the level of significance of $p<0.05$.

RESULTS

Results of ANOVA on growth of herbage yield (g m^{-2}) and dry matter ratio (%) are presented in Table 1. Differences between period means as a result of variance analysis are statistically significant. Results of the Tukey test are indicated in Latin letters above the means.

Herbage yield: The average herbage quantity obtained from an area of 1 m^2 on April 15 when the 1st period measurements were taken at the beginning of the vegetation period was 241.00 g m^{-2}. On May, the largest increase among the monthly periods was marked when the average reached 441.83 g m^{-2} (The amount of increase between April 15 and May 15 was 441.83-241.00 = +200.83 g m^{-2}). On June 15, the next measurement date, the average herbage quantity obtained from an area of 1 m^2 was 574.66 g m^{-2} (The amount of increase between May 15 and June 15 was 574.66-441.83 = $^{+}$132.80 g m^{-2}). On July 15, the average herbage quantity obtained from an area of 1 m^2 increased by 60.34 g m^{-2} in comparison with June 15 and reached 635.00 g m^{-2}. Since, measurements taken on August 15 and September 15 showed no increase in herbage quantities, there is no difference in figures compared to July 15 ($p<0.05$).

Dry matter ratio: Measurements taken on April 15 showed an average dry matter ratio of 32.03% in the biomasses. On May 15, the dry matter percentage ratio marked the greatest increase among the periods (an increase of $^{+}$11.23% from April 15 to May 15) and reached 43.26%. The dry matter ratio in the biomass samples taken on June 15 marked an increase of +10.57 compared to May 15 and reached 53.83%. The dry matter ratio in the biomass samples taken on July 15 showed a very small increase (+3.02) and reached 56.85%. Results of analyses conducted after this period on August 15 and September 15 did not show a statistical difference and there was no increase in dry matter ratios ($p<0.05$). In other words, no difference was found in the dry matter content (%) between July 15 and September 15.

Grazing capacity of kermes oak scrublands: In order to determine the grazing capacity of kermes oak for pure hair goats, the herbage yield obtained from an area of 1 m^2 was multiplied with the percentage ratio of dry matter contents found in the same period and dry matter yields obtained from an area of 1 ha were calculated. Herbage yields and dry matter yields in Table 2 are in kg ha^{-1}.

The quantity of dry matter obtained from an area of 1 ha during a vegetation period ranges between 772.0 and 3689.4 kg ha^{-1}. The quantity of dry matter obtained from an area of 1 ha from the beginning of the vegetation period until April 15 is 772.0 kg. This figure marked its greatest increase among the monthly periods on May 15, reaching 1911.3 kg ha^{-1}. The average quantity of dry matter obtained from an area of 1 ha on June 15 was 3093.3 kg and on July 15 was 3610.0 kg. The quantity of dry matter obtained on August 15 and September 15 was 3649.3 and 3689.4 kg ha^{-1}, respectively.

The numbers provided in Table 2 are valid for circumstances when kermes oak coverage of the land is at 100%. However, under normal circumstances, it may not be possible to find kermes oak scrubland with a 100% land coverage. Furthermore, it may not be possible to find vegetation where kermes oak is the native variety. Therefore, Table 3 provides dry matter yields for kermes oak scrubland with different land coverage and mixed scrub species ratios. By taking the Table 3 as a reference

Table 1: Field measurement results of the study

	Herbage yield (g m^{-2})		Dry matter ratio (%)	
Date	Min.-Max.	Mean±SD	Min.-Max.	Mean±SD
April 15 2008	80.0-410.0	241.00±98.830^{d}	31.75-32.38	32.03±0.32^{d}
May 15 2008	175.0-750.0	441.83±174.53^{c}	42.55-43.97	43.26±0.710^{c}
June 15 2008	260.0-890.0	574.66±196.84^{b}	53.07-54.80	53.83±0.880^{b}
July 15 2008	280.0-980.0	635.00±212.40^{a}	56.26-57.42	56.85±0.580^{a}
Aug 15 2008	290.0-990.0	636.33±214.82^{a}	57.13-57.72	57.35±0.320^{a}
Sept 15 2008	280.0-980.0	636.66±210.45^{a}	57.79-58.13	57.95±0.170^{a}

$^{a, b, c, d}$Means in the same column followed by the same letters are not significantly different at the 0.05 level

Table 2: Herbage and dry matter yields of kermes oak at different times

Date	Herbage yield (kg ha^{-1})	Dry matter yield (kg ha^{-1})
April 15 2008	2410.0	772.0
May 15 2008	4418.3	1911.3
June 15 2008	5746.6	3093.3
July 15 2008	6350.0	3610.0
Aug 15 2008	6363.3	3649.3
Sept 15 2008	6366.6	3689.4

Table 3: Dry matter yields of kermes oak at different land coverage ratios

Date	10%	30%	50%	70%	100%
	(kg ha^{-1})				
April 15 2008	77.2	131.6	386.0	540.4	772.0
May 15 2008	191.1	573.3	955.5	1337.7	1911.3
June 15 2008	309.3	927.9	1546.5	2165.1	3093.3
July 15 2008	361.0	1083.0	1805.0	2527.0	3610.0
Aug 15 2008	364.9	1094.7	1824.5	2554.3	3649.3
Sept 15 2008	368.9	1106.7	1844.5	2582.3	3689.4

Table 4: Number of days that 1 goat can be grazed in an area of 1 ha as per the ratio of land coverage

Date	10%	30%	50%	70%	100%
	day/goat/ha				
April 15 2008	38.60	65.80	193.00	270.20	386.00
May 15 2008	95.55	286.65	483.30	668.85	955.65
June 15 2008	154.65	463.95	773.25	1082.55	1546.65
July 15 2008	180.50	541.50	902.50	1263.50	1805.00
Aug 15 2008	182.45	547.35	912.25	1277.15	1824.65
Sept 15 2008	185.45	553.35	922.25	1291.15	1844.70

Table 5: Number of pure hair goats that can be grazed in an area of 1 ha for 1 year as per the ratio of land coverage

Date	10%	30%	50%	70%	100%
	ha/goat/year				
April 15 2008	0.10	0.18	0.52	0.74	1.05
May 15 2008	0.26	0.78	1.32	1.83	2.61
June 15 2008	0.42	1.27	2.11	2.96	4.23
July 15 2008	0.49	1.48	2.47	3.46	4.95
Aug 15 2008	0.50	1.49	2.49	3.49	4.99
Sept 15 2008	0.51	1.51	2.52	3.53	5.05

point, yield values for real-life land conditions with different land coverage and mix ratios can be calculated. Using the values in Table 3, the unit area (1 ha) grazing capacity of kermes oak and the number of pure hair goats that can be grazed in this area were calculated. Pure hair goats consume dry matter that is 3-4% of their live body weight in a day. The live body weight of an adult pure hair goat that has grown under Turkey's conditions ranges from 40-50 kg. In determining, the pure hair goat grazing capacity per unit area of kermes oak scrubland, this study assumed a live body weight of 50 kg and estimated that a dry matter consumption at 4% of this weight would take place (Gorgulu, 2002). Accordingly, a pure hair goat weighing 50 kg would consume 2 kg of dry matter in a day. By dividing the dry matter yields obtained at each period by the daily dry matter consumption of a pure hair goat, the emerging number will be the number of days that a goat can be grazed at each period at different land coverage ratios. The numbers provided in Table 4 have thus been derived.

According to Table 4, a kermes oak area of 1 ha with a land coverage ratio of 10% could not produce sufficient dry matter at any period to be able to feed 1 pure hair goat for 1 year. An area with a land coverage ratio of 30% could reach sufficient dry matter yield to be able to feed 1 goat for 1 year on June 15 and areas with a land coverage ratio of 50 and 70% could reach this figure on May 15. An area with a 100% land coverage of kermes oak reaches sufficient dry matter yield to be able to feed 1 goat for 1 year on April 15, the 1st period and this figure increases with the periods that follow.

Table 5 provides the number of pure hair goats that can be grazed in an area of 1 ha for 1 year depending on the vegetation period as per the ratio of kermes oak land coverage.

Accordingly, the number of pure hair goats that an area of 1 ha with a 100% of kermes oak land coverage can feed for 1 year ranges between 1 and 5. The number of pure hair goats that can be grazed in the unit area changes with the ratio of kermes oak land coverage and the quantity of dry matter obtained at different periods. Due to the fact that grazing in areas covered with kermes oaks in countries neighboring the Mediterranean mostly begins and is conducted within the month of June, it seems logical that the figures pertaining to June 15 in Table 5 are used in our country. Because, in the area researched it has been revealed with phenological observations that the growth of roots and development of leaves of the kermes oak take places in April whereas blooming and fertilization take place in May. As the grazing to be conducted in these periods harms the growth and development of kermes oaks, the yield in herbage and dry matter remain low. In the periods following May 15, the increase in green herbage stops, the leaves harden due to summer drought and the shoots become wooden. Therefore, the highest number of pure hair goats that 1 ha of kermes oaks fully covering the land where they are located (%) can feed for a period of 1 year upon using the figures relating to June 15 is 4.

CONCLUSION

Goats are widespread in many different climactic and geographical regions around the world. Pure hair goats may be raised in very arid climactic conditions, in highly sloped steppe fields, which are not suitable for agriculture and have very scarce vegetation. Under suitable maintenance and administration conditions, it is possible to benefit efficiently from pure hair goats (Boyazoglu and Morand-Fehr, 2001).

The fields covered with kermes oak in the Aegean and Mediterranean Regions encompassing also the test area of this research, are fields where the inhabitants of rural regions raise pure hair goats and are not suitable for planting industrial forests. These areas are suitable for raising pure hair goats in terms of herbage yield and the content of nutritional ingredients. According to the action plan for reducing damage caused by goats enforced by the Forest Administration in 2008, the areas to be allowed for grazing pure hair goats will bear such characteristics. These areas have specific locations and amount in forest management plans and maps. The forest administration should designate these areas, allocate these to villagers raising pure hair goats and end the hostility between them.

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