Journal of Animal and Veterinary Advances 9 (4): 716-720, 2010
ISSN: 1680-5593

Yield and Nutritive Value of Anti-Taurus Mountain Rangeland Shrubs in Turkey

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Abstract: Shrubs provide the bulk of feed for goats in the Mediterranean agropastoral farming systems, yet quantitative data on productivity and nutritive value of highland shrubs species that is needed to develop rangeland management strategies are limited. Edible Fodder (EF) yield and concentrations of CP, ADF, NDF and IVOMD in the EF of shrubs were evaluated at Saksak and Candir in Yayladagi County of Antakya on the Anti-Taurus Mountains in Turkey. Significant variations in EF yield (8-4003 kg DM ha^{-1}), CP (5.9-23.1%), ADF (19.9-38.4%), NDF (30.9-54.2%) and IVOMD (22.7-56.7%) were recorded among the shrubs at Saksak. Similarly, variations in EF yield (202-1523 kg DM ha^{-1}), CP (5.9-13.2%), ADF (22.8-37.7%), NDF (38.3-53.6%) and IVOMD (29.3-51.4%) were significant among the shrubs at Candir. Based on digestible organic matter yield, the shrubs could be ranked as: *Daphne sericea*>*Calycotome infesta*>*Styrax officinalis*>*Cistus salviaefolius*>*Rhamnus alaternus*>*Laurus nobilis*>*Juniperus oxycedrus*>*Quercus coccifera*>*Pistacia terebentis* in Saksak and *Daphne sericea*>*Styrax officinalis*>*Cistus salviaefolius*>*Juniperus oxycedrus*>*Quercus coccifera*>*Pistacia terebentis* in Candir. *D. sericea*, *S. officinalis*, *C. salviaefolius* and *C. infesta* showed greater potential for development of agroforestry technologies to increase rangeland productivity in the Anti-Taurus Mountains region and similar highland environments in other parts of the world. Further research on cheaper methods of establishment, defoliation options to optimize and sustain edible fodder and wood production, fodder quality in terms of outputs of livestock products may be needed.

Key words: Chemical composition, edible fodder, eastern mediterranean shrubs, goats, highland, *in vitro* digestibility, Turkey

INTRODUCTION

The grazing lands of the Taurus Mountains are subject to heavy, uncontrolled grazing pressure and the forage production capacities of these lands are gradually decreasing. The reason for this retrogressive trend includes a complex mixture of several interrelated problems of socio-economic, judiciary, political and technical inadequacies (Tukel and Hatipoglu, 1998).

Located on the Anti-Taurus Mountains in Turkey, Yayladagi County of Antakya has limited land, water and capital resources. As a result, livelihoods of the majority of small-scale farmers in the region depend on rangeland based livestock production using crosses of local (Hair) and Damascus (Shami) goats for milk, meat and manure (Haenlein, 1998; Boyazoglu and Morand-Fehr, 2001; Gursoy, 2005; Mavrogenis, 2005) and cropping of tobacco and wheat with manure as the main nutrient source. Recent reduction in state purchased tobacco to only 200 kg per household has further reduced household incomes. Hence, most farmers perceive increase in production of livestock products as the fastest way of compensating for the lost incomes, if seasonal feed deficits that constrain increased livestock production could be reduced by improving the degraded rangelands which provide the bulk of feed (Le Houerou, 1986; Papanastasis, 2000).

Goats are reported to be preferably better browsers of shrub vegetation than grazers of herbaceous vegetation (Nastis, 1996; Rogosic *et al*., 2006).

Although, there have been several notable studies on Taurus Mountain rangelands (Tukel, 1984; Ozer and Tukel, 1988; Genckan and Celen, 1994; Heil *et al*., 1999; Cinar, 2001), they primarily describe the general range vegetation and forage producing capacities but not the feeding values under different ecological conditions in Turkey. Most of these studies are unavailable to the interested foreign readers. There have also been extensive works on flora of Anti-Taurus Mountains (Yildiz, 1982; Cakan, 1997). Recently, just a few research works

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appeared dealing with the nutritive values of some mediterranean shrub and tree species (Kamalak *et al*., 2004; Karabulut *et al*., 2006). However, quantitative data is limited on the productivity and nutritive value of Mediterranean highland shrub species, especially those preferred by goats (Le Houerou, 1986; Papachristou, 2000; Aharon *et al*., 2007; Ainalis *et al*., 2006). Also, intra-species and inter-species variations in fodder yield and quality have not been widely reported. Such information is needed to develop rangeland improvement plans and agroforestry technologies and to prioritize shrub research (Le Houerou 1986, 1994). These reports on a study to quantify edible fodder yield and nutritional value of shrubs in the Anti-Taurus Mountains region in Turkey.

MATERIALS AND METHODS

Study sites: The experiment was conducted from 2002-2003 at two locations, namely Saksak (1750 m asl, 35°58' 34.55"N and 36°05'37.58"E) and Candir (1235 m asl, 35°56'13.30"N and 36°00'49.22"E) in Yayladagi County of Antakya on the Anti-Taurus Mountains. Yayladagi County is representative of the Taurus Mountains region in the Mediterranean Coast of Turkey. Annual rainfall average 750 mm, humidity 75%, with minimum and maximum temperatures of 6 and 33°C, respectively over a 30 years period. Monthly maximal temperatures were lower but minimal temperatures were higher during the experimental period. More precipitation received in February, August and December of the experimental period than the long term monthly precipitation in the study area. However, there was no significant variation for the relative humidity.

Estimating edible fodder yield: Data were collected from three sites at Saksak and two sites in Candir. At each site, three plots (replications) of size 5×10 m were randomly selected and marked. Shrub species in each replicate were identified. Shrub biomass was measured using the reference unit method (Andrew *et al*., 1979) to estimate the biomass of each shrub individually and then the total biomass of the plantation. Biomass was estimated at three monthly intervals on: 6 April, 8 July and 13 October 2002 and 15 January 2003 by 4 persons. Thereafter, leaves and twigs <10 mm in diameter (Edible Fodder, EF) were separated from the sample branch and weighed fresh. The samples were oven-dried at 70°C for 48 h to determine Dry Matter (DM) content. Total EF yield was estimated from the sum of the four harvests.

Chemical composition and *in vitro* digestibility analysis: The oven-dried EF samples for each shrub species were bulked by replicate at each site and ground through a 1 mm screen to determine total Nitrogen (N) by the Kjeldahl method (AOAC, 1990). Crude Protein (CP) was calculated as N×6.25. Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF) were analyzed according to Van Soest *et al*. (1991). *In vitro* Organic Matter Digestibility (IVOMD) was determined by a modified two stage procedure (Moore and Mott, 1974).

Statistical analysis: Data were analyzed separately for Saksak and Candir using the General Linear Models (GLM) procedures (SAS Institute, 1990). Edible fodder yield data were analyzed as a split-plot experiment with site as main-plots and shrubs as sub-plots, whilst the fodder quality data were analyzed as a randomized block experiment using sites as replicates. Univariate correlation analyses were used to establish relationships between concentrations of CP, ADF, NDF and IVOMD in the edible fodder. When significance is not given in the text, it implies to minimum ($p<0.05$).

RESULTS AND DISCUSSION

Fodder yield: Edible fodder varied significantly among the shrubs at both locations, with yield at Saksak (Fig. 1a) being relatively higher than Candir (Fig. 1b). At Saksak, yield varied significantly from 8 kg DM ha^{-1} for *C. salviaefolius* to 4003 kg DM ha^{-1} for *Q. coccifera*; whilst at Candir, yield varied from 202 kg DM ha^{-1} for *D. sericea* to 1523 kg DM ha^{-1} for *Q. coccifera*.

Crude protein concentration: Table 1 presents the nutritive value of the EF. The CP concentration ranged from 5.9% in *J. oxycedrus* at both locations to 23.1% in *C. infesta* at Saksak and 13.2% in *P. terebentis* at Candir.

Cell wall concentration: At Saksak, concentrations of ADF ranged significantly from 19.9% for *C. infesta* to 38.4% for *Q. coccifera*, whilst NDF ranged from 30.9% for *C. infesta* to 54.2% for *Q. coccifera* (Table 1). At Candir, the ADF concentration varied significantly among the shrubs but the NDF did not differ. *P. terebentis* had the lowest ADF (22.8%) and *Q. coccifera* the highest (37.7%).

***In vitro* organic matter digestibility:** At the Saksak, the IVOMD concentration ranged from as low as 22.7% for *P. terebentis* to 56.7% for *D. sericea*; whilst at the Candir it ranged from 29.3% for *P. terebentis* to 51.4% for *D. sericea*.

Correlations between determinants of fodder quality: Positive and significant correlations were recorded between concentrations of CP and IVOMD (Saksak,

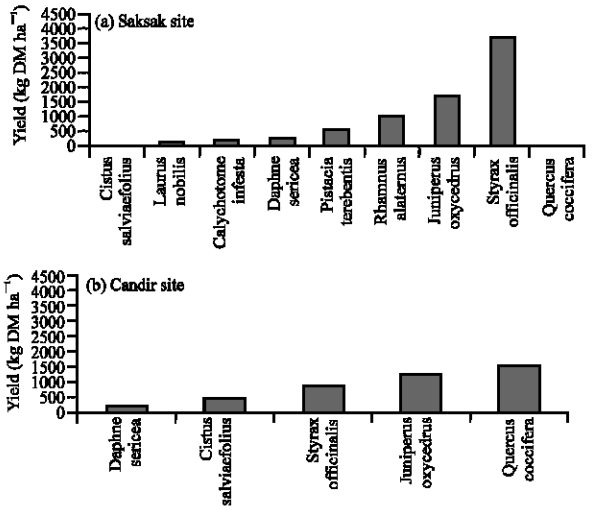

Fig. 1: Edible fodder yield of rangeland shrub species at Saksak (a) and Candir (b) in Yayladagi County of Antakya, Turkey

Table 1: Chemical composition and *in vitro* organic matter digestibility of edible fodder of rangeland shrub species at Saksak and Candir in Yayladagi County of Antakya, Turkey

Locations	Shrubs	[1]CP	[1]ADF	[1]NDF	[1]IVOMD
		(%)			
Saksak	*Calycotome infesta*	23.10	19.90	30.90	54.50
	Cistus salviaefolius	10.20	24.00	43.80	41.80
	Daphne sericea	11.00	26.70	36.80	56.70
	Juniperus oxycedrus	5.90	36.30	41.30	32.60
	Laurus nobilis	10.70	33.00	48.40	35.40
	Pistacia terebentis	11.60	26.00	36.10	22.70
	Quercus coccifera	7.90	38.40	54.20	31.60
	Rhamnus alaternus	9.60	29.30	41.60	40.70
	Styrax officinalis	10.60	23.90	40.20	46.80
	Mean	11.18	28.61	41.48	40.31
	LSD ($p<0.05$)	2.72	4.46	7.67	9.16
	Minimum	5.90	19.90	30.90	22.70
	Maximum	23.10	36.30	54.20	56.70
Candir	*Cistus salviaefolius*	10.90	33.60	49.20	41.30
	Daphne sericea	9.60	29.90	40.80	51.40
	Juniperus oxycedrus	5.90	36.30	41.70	35.60
	Pistacia terebentis	13.20	22.80	38.30	29.30
	Quercus coccifera	8.50	37.70	53.60	29.60
	Styrax officinalis	11.60	27.20	43.10	45.70
	Mean	10.00	31.30	44.50	38.80
	LSD ($p<0.05$)	2.22	7.56	16.11	5.24
	Minimum	5.90	22.80	38.30	29.30
	Maximum	13.20	37.70	53.60	51.40

[1]CP: Crude Protein; ADF: Acid Detergent Fibre; NDF: Neutral Detergent Fibre; IVOMD: *In vitro* Organic Matter Digestibility

r = 0.61; Candir, r = 0.46) and concentrations of ADF and NDF (Saksak = 0.51). In contrast, negative and significant correlation were recorded between concentrations of CP and ADF (Saksak, r = -0.75; Candir, r = -0.72), ADF and IVOMD (Saksak, r = -0.62; Candir, r = -0.65) and NDF and IVOMD (Saksak, r = -0.47). In agreement with the results, significant variations in EF yield of shrubs have been reported (Le Houerou, 1986, 1994; Larbi *et al*., 2007). The differences in yield may relate to variations in anatomical, physiological and morphological characteristics associated with the acquisition of moisture, lights and nutrients for biomass production (Le Houerou, 1986, 1994; Dong and Zhang, 2001). They could also reflect differences among the shrub in residual buds, leaf area index and storage of carbohydrate reserves after defoliation.

Ranges in CP concentration in the current study are consistent with those reported for several shrubs (Le Houerou, 1994; Papachristou, 2000; Haddi *et al*., 2003; Ammar and Gonzalez, 2005). The significant differences in CP concentration among the shrubs could be partly due to differences in leaf: twig ratio in the samples used for the chemical analysis, cell wall concentration and thickening (Wilson, 1994). All but *J. oxycedrus* and *Q. coccifera* had CP concentration >8.0%, below which digestibility is depressed and voluntary forage intake drops (Minson, 1990). This suggests that most of the shrubs could effectively provide supplemental N, when grazed with native pastures or when offered to stall-fed ruminants fed basal diets of low N cereal crop residues. The availability of the N, however, will depend on the concentration of secondary compounds such as condensed tannins which influence adhesion, colonization and enzymatic activity of the rumen microbial ecosystem and consequently the degradation of the different dietary fractions (Guimaraes-Beelen *et al*., 2006).

The significant differences in EF cell-wall concentrations among the shrubs confirm earlier reports (Papachristou, 2000; Haddi *et al*., 2003; Ventura *et al*., 2004; Larbi *et al*., 2007) possibly due to anatomical or morphological differences related to cell wall rigidity (Wilson, 1994) and leaf:twig ratio in the samples used for the chemical analyses. The observed differences in ADF and NDF concentrations among the shrubs could have implications for their use as fodder, because cell wall concentration in EF of shrubs is negatively correlated with palatability, voluntary DM intake and potential DM degradability (Kaitho *et al*., 1998; Larbi *et al*., 1998).

Significant differences among the shrubs in the IVOMD concentration confirm earlier reports (Le Houerou, 1986; Papachristou, 2000; Larbi *et al*., 2007). The observed differences in the CP, ADF and NDF concentrations (Table 1) and secondary compounds such as tannin in the EF (Ventura *et al*., 2004) may be partly accountable. It could also be due to differences in the configuration of cell-wall polysaccharides and their effect on rumen microbial attachment and colonization of digesta particles (Cheng *et al*., 1984). Larbi *et al*. (2005, 2007) reported significant positive and negative correlations between the determinants of shrub EF which agree with

the results. The significant correlations between CP and IVOMD and ADF and IVOMD suggest that IVOMD could be predicted from either CP or ADF under situations where facilities for determining IVOMD are not available. Similarly, the significant correlation between CP and ADF indicates that ADF could be predicted from CP.

High milk production in the Damascus x Kil Goats found on Anti-Taurus Mountains (Acuz, 2005) could be attributed to the rich *Q. coccifera* composition of the rangelands. As far as range management concerns, higher yields together with slightly higher CP and IVOMD of *Q. coccifera* and *J. oxycedrus* in the Saksak site indicate that more animal units can be stocked in the Saksak rangeland than the Candir site. It is reported that *Q. coccifera* can meet the nutritional requirements of goats all year round but requires supplementation in winter (Papanastasis and Liacos, 1980).

CONCLUSION

The research priorities in order to reach sound management practices should be focused on determining correct carrying capacities of the study sites as well as following appropriate grazing periods in the area.

ACKNOWLEDGEMENTS

The researchers would like extend their gratitude to Cukurova University Research Fund and ICARDA (International Center for Agricultural Research in the Dry Areas, Aleppo, Syria) and Antoine Makzume Ltd. Co. of Iskenderun, Antakya, for co-funding of the project. They are also indebted to Mrs. Monika Zaklouta of ICARDA for the analyses of the samples.

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