

Forage chemical composition of a grazed and an ungrazed kermes oak (*Quercus coccifera* L.) shrubland in northern Greece

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Abstract

Kermes oak shrublands (*Quercus coccifera* L.) are an important source of nutrients for grazing goats during the critical summer period in Greece. This study was carried out to identify the growing plant species in a grazed (GS) and an adjacent ungrazed for 10 years (UGS) kermes oak shrubland at the Municipality of Anthemouda, Chalkidiki, northern Greece, as well as to determine their chemical composition. Two experimental cages 2x2 m were placed in each shrubland in order to identify the herbaceous and woody species and to collect samples. The collected samples were analyzed for ether extracts (EE), crude fibre (CF), crude protein (CP), calcium (Ca²⁺), phosphorus (P⁵⁺), sodium (Na⁺) and potassium (K⁺) content determination. Mean CF concentration of shrubs was not different ($p < 0.05$) between the GS (21.3% DM) and the UGS (19.7% DM). Higher CP content was found in forbs (11.4 % DM) followed by grasses (9.4% DM) and shrubs (7.4% DM) of the GS. On the contrary, higher mineral content (1316.7 mg Ca²⁺/100 g DM, 695.5 mg P⁵⁺/100 g DM, 1538.6 mg Na⁺/100 g DM, and 953.6 mg K⁺/100 g DM) was observed in the UGS, as only shrub species comprised the vegetation of this shrubland.

Key words: Mediterranean shrublands, chemical composition, plant groups

Introduction

Shrublands occupy extensive areas of the Mediterranean region covering a total surface of 110,854 km² (Calvo et al. 2011). Generally, their vegetation is composed of both evergreen and deciduous shrubs with an understorey of herbaceous species. Kermes oak (*Q. coccifera* L.) is the dominant vegetation of evergreen sclerophyllous shrublands, covering around 1500 km² or 50% of the total shrubland area of Greece (Papanastasis 1997). These areas are considered as natural grazing lands, especially for goats, but they also provide fuelwood for the rural communities and a natural habitat for the wildlife, while they protect soil from erosion. Through grazing, goats convert this otherwise unused natural

resource into animal products of high biological value. In the heterogeneous forage environment of evergreen shrublands, grazing animals select their diet from various plant species and plant parts, which have obviously different chemical composition. It is known that the chemical composition of forage species common in such environments is widely variable, depending on species, plant parts, phenological stage, environmental conditions as well as previous grazing management (Yiakoulaki 1987, Decandia et al. 2007, Papanastasis et al. 2008).

Information about chemical composition of the dominant plant species in kermes oak shrublands are relatively limited (Yiakoulaki 1987, Yiakoulaki and Nastis 1993, Parkal et al. 2011). Such knowledge will assist in achieving the timely utilization of forage plants, help predict deficiencies of nutrients and suggest supplementation needs.

The objectives of this study were to identify the growing plant species in a grazed (GS) and an adjacent ungrazed for 10 years kermes oak shrubland (UGS) at the district of Chalkidiki peninsula, northern Greece and also to determine their chemical composition.

Materials and Methods

The study was conducted at the Municipality of Anthemouda in the district of Chalkidiki peninsula, northern Greece, during the summer of 2009. Two kermes oak (*Quercus coccifera* L.) shrublands -a grazed (GS) and an adjacent ungrazed for over 10 years (UGS)- were selected covering an area of 0.5 ha each. Mean annual precipitation of 2009 was 754 mm while mean annual temperature was 14.21°C. Two experimental cages sized 2 x 2 m, fenced with rope, were placed in preselected points in each shrubland and the present herbaceous and woody species were identified. Species nomenclature followed Flora Europea (Tutin et al. 1968-1993). After that the herbaceous and woody vegetation were clipped in situ with hand scissors at 5 cm above the soil surface (Odum 1971). The harvested samples were categorized in three plant groups: grasses, forbs and shrubs. The samples were dried at 60°C for 48h, ground to pass a 1-mm screen of a Willey mill and were analyzed for ether extracts (EE) and crude protein (CP) content according to the AOAC methods (AOAC, 1995). Crude fiber was determined by the Bellucci method (Bellucci 1932). Ca, Na, and K concentrations were determined by flame photometry and that of P by spectrophotometric methods (Khalil & Manan, 1990). Data on plant species were subjected to analysis of variance. The Fisher's Protected Least Significant Difference (LSD) test (Fisher 1966) was used for detecting mean differences ($p \leq 0.05$).

Results and Discussion

In the GS were found the following 29 taxa: 3 grasses (*Cynodon dactylon* (L.) Pers., *Vulpia ciliata* Dumort., *Setaria viridis* (L.) P. Beauv.), 20 forbs (*Anthemis cotula* L., *Dianthus diffusus* Sibth. & Sm., *Alyssum heldreichii* Hausskn, *Trifolium lappaceum* L., *Plantago lanceolata* L., *Erysimum graecum* Boiss. & Heldr., *Trifolium angustifolium* L., *Sinapis arvensis* L., *Malva montana* Forssk. sec. C.Chr., *Trifolium repens* L., *Teucrium polium* L., *Trifolium arvense* L., *Centaurea diffusa* Lam., *Erodium moschatum* (L.) L'Hér., *Sedum tenuifolium* (Sm.) Strobl, *Scutellaria columnae* All., *Asparagus acutifolius* L., *Cirsium arvense* (L.) Scop., *Medicago minima* (L.) Bartal., *Carlina vulgaris* L.) and 6 shrubs (*Juniperus oxycedrus* L., *Cistus incanus* L., *Crataegus oxyacantha* L., *Erica arborea* L., *Phillyrea latifolia* L., *Quercus coccifera* L.) On the other hand only 5 taxa (shrub species) were found in the UGS: *Crataegus oxyacantha* L., *Erica arborea* L., *Juniperus oxycedrus* L., *Phillyrea media* L. and *Quercus coccifera* L. Kermes oak was the predominant shrub species in both shrublands (GS and UGS). The absence of herbaceous species in the UGS is in accordance with findings of Metera et al. (2010), who referred that in many areas of Europe, low or no grazing pressure leads to the creation of unexploited areas that are covered by shrubs. In our study the shrubs of the UGS were tall (more than 1.50 m) and dense. Tall and dense kermes oak shrubs are often found in the shrublands of the Mediterranean zone. These shrubs are difficult to be reached or penetrated by grazing animals (Yiakoulaki and Nastis 1998).

No significant differences ($p \leq 0.05$) were observed in the EE content of the shrub species found both in the GS and UGS. Moreover, no significant differences were found among the three plant groups of the GS (Table 1).

Mean crude fibre content of shrubs species in the GS and UGS did not differ ($p < 0.05$). However, higher ($p \leq 0.05$) CF values were found for the grasses of GS compared to forbs and shrubs, probably due to the rapid maturation of grasses during the summer.

Mean CP content of the plant groups in this study ranged from 6.4 to 11.4%. The minimum CP value was recorded for the shrubs of UGS, while the maximum for the forbs of GS. Crude protein is an essential dietary nutrient for animals' maintenance, growth and reproduction (Liamadis, 2003). The recommended standards of crude protein for small ruminants (of weight 30 kg) are 8% for maintenance and 10-12% for lactation (NRC 1985). CP content of forbs and grasses approached or exceeded the animals' requirements for maintenance and lactation. However, CP content

of shrubs in both shrublands was insufficient to meet even the maintenance requirements.

Table 1. Chemical composition of the grazable material in the grazed (GS) and ungrazed shrublands (UGS)

Season	Plant Group	EE (% DM)	CF (% DM)	CP (% DM)	Ca ²⁺ /100 g DM	P ⁵⁺ /100 g DM	Na ⁺ /100 g DM	K ⁺ /100 g DM
SUMMER	<u>Grazed shrubland (GS)</u>							
	Grasses	1.4 ^a	26.5 ^b	9.3 ^{a,b}	294.1 ^a	581.5 ^{a,b}	787.4 ^a	583.1 ^{a,b}
	Forbs	1.9 ^a	20.7 ^a	11.4 ^b	1315.5 ^b	687.9 ^a	856.1 ^a	792.0 ^{a,c}
	Shrubs	1.9 ^a	20.8 ^a	7.4 ^a	559.4 ^a	350.5 ^b	936.9 ^a	463.6 ^b
	Mean	1.9	21.3	10.3	1053.4	607.1	865.7	702.4
	S.E.	0.2	0.7	0.7	160.8	54.3	54.2	46.1
	<u>Ungrazed shrubland (UGS)</u>							
	Shrubs (Mean)	2.1 ^a	19.7 ^a	6.4 ^a	1316.7 ^b	695.5 ^a	1538.6 ^b	953.6 ^c
	S.E.	0.6	1.0	0.7	344.4	130.2	18.8	125.9

Mean with different letters (a–c) along the same column differ at ($p \leq 0.05$).

Ca²⁺: Calcium; CF: Crude Fibre; CP: Crude Protein; EE: Ether Extracts; P⁵⁺: Phosphorus; Na⁺: Sodium; K⁺: Potassium; S.E.: Standard Error of Mean

Ca, P, Na and K content of shrubs of the UGS was higher ($p \leq 0.05$) than that of shrubs of the GS (Table 1). Grasses of the GS had the lower Ca value compared to forbs and shrubs. However, significant difference ($p \leq 0.05$) was found only for forbs. Similarly, lower Ca content in grasses compared with forbs and shrubs has been reported by Yiakoulaki and Nastis (1993). On the other hand, forbs tended to maintain greater P and K content than shrubs and grasses. Regarding the Na content of the three plant groups of the GS there were no significant differences ($p \leq 0.05$).

The recommended Ca requirements of goats (30 kg) for maintenance and medium activity are 300mg/100g DM when the consumption is 1 kg of DM per day. Dry matter intake of goats grazing in Mediterranean shrublands has been reported by Yiakoulaki (1992) to be 840 g DM/day. All plant groups contained sufficient Ca to meet the requirements of goats except grasses. Na, P and K content of all plant groups reached or exceeded the recommended levels for goats (100 mg/100 g DM, 210 mg/100g DM and 500 mg/100g DM, respectively).

Conclusions

More taxa (29) were found in the GS compared to UGS (5). Specifically, there were found 3 grasses, 20 forbs and 6 shrubs in the GS, while only 5 species (shrubs) in the UGS. As a consequence, the presence of herbaceous species resulted to higher CP in the GS compared to UGS. On the contrary, higher mineral content was observed in the UGS as only shrub species were present in this shrubland. The studied mineral content of all plant groups has approached or exceeded the recommended levels of goats.

References

- AOAC. 1995.** Association of Official Analytical Chemists. Official methods of analysis. 16th ed. Washington: AOAC International. 1094pp.
- Bellucci C. 1932.** La determinazione della cellulosa nelle farine di frumento e dei sottoprodotti. *Annali di chimica applicata*, 22(1):25-31.
- Calvo L., J. Baeza, E. Marcos, V. Santana and V. P. Papanastasis. 2012.** Post-Fire Management of Shrublands. In: F. Moreira et al. (eds). Post-Fire Management and Restoration of Southern European Forest. Managing Forest Ecosystems 24, Springer Science. pp. 293-319.
- Decandia M., M. Yiakoulaki, G. Pinna, A. Cabiddu and G. Molle. 2008.** Foraging behaviour and intake of goats browsing on Mediterranean shrublands. In: Dairy Goats Feeding and Nutrition (Cannas and Pulina Eds.). CAB International, UK, pp. 161-188.
- Fisher R.A., 1966.** The Design of Experiments, 8th ed. Hafner, New York. 248pp.
- Khalil I.A. and F. Manan. 1990.** Colorimetry and Flame photometry. In: Chemistry One (Bioanalytical chemistry) 2nd edition. Taj printing press, Peshawar, Pakistan. pp. 131-157.
- Liamadis D.G., 2003.** Physiology of Animal Nutrition, Vol. 2. University Studio Press, Thessaloniki, Greece. 612 pp.
- Metera E., T. Sakowski, K. Słoniewski and B. Romanowicz. 2010.** Grazing as a tool to maintain biodiversity of grassland – a review. *Animal Science Papers and Reports*, 28(4):315-334.
- NRC. 1985.** Nutrients Requirements of Sheep, 6th Revised Edition. National Academy Press, Washington, DC. 99pp.
- Odum E.P. 1971.** Fundamentals of Ecology, 3rd ed. W.B. Saunders Co., Philadelphia and London, 544 pp.
- Papanastasis V.P. 1997.** Improvement of kermes oak shrublands for sustainable use by livestock (in Greek with English abstract), In: V.Papanastasis (ed). 1st National Rangelands Congress 'Sustainable Utilization of Rangelands and Pastures', Drama 6-8 November 1996. Hellenic Range and Pasture Society, Publication No 4, pp. 261-270.
- Papanastasis V.P., M.D. Yiakoulaki, M. Decandia, O. Dini-Papanastasi. 2008.** Integrating woody species into livestock feeding in the Mediterranean areas of Europe. *Animal Feed Science and Technology*, 140(1):1-17.
- Parlak A., A. Gökkus, H. Hakyemez and H. Bayetekin. 2011.** Forage yield and quality of kermes oak and herbaceous species throughout a year in Mediterranean zone of western Turkey. *Journal of Food, Agriculture & Environment*, 9(1):510-515.
- Tutin T.G., N.A. Burges, A.O. Chater, J.R. Edmondson, V.H. Heywood, D.M. Moore, D.H. Valentine, S.M. Walters and D.A. Webb. 1968-1993.** *Flora Europaea*, Vol. 1-5. Cambridge University Press.

Yiakoulaki M.D. 1987. Nutritive value of range species as determined with laboratory procedures and their contribution to meet animal demands. *Scientific Annals of the Department of Forestry and Natural Environment*, Vol. A, No 10, Aristotle University of Thessaloniki, Greece, pp. 381-401. (In Greek with summary in English).

Yiakoulaki M.D. 1992. Effects of different proportions of shrubby and herbaceous vegetation on intake by goats. Ph.D. Dissertation (in Greek), Aristotle University of Thessaloniki. 115 pp.

Yiakoulaki M.D. and A.S. Nastis. 1993. Mineral content of selected forage species common in the mediterranean shrublands". 7th meeting of the FAO subnetwork on "Mediterranean pastures and fodder crops". Chania, Crete. REUR Technical Series 28. FAO, Rome. pp. 137-140.

Yiakoulaki M.D. and A.S. Nastis. 1998. A modified faecal harness for grazing goats in Mediterranean shrublands. *Journal of Range Management*, 51(5):545-546.