



Ecological and vegetation characterization and livestock production of a mountain marginal area of N-W Sardinia

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Abstract

Aim of this work was the ecological and vegetation characterization of a mountain marginal area of N-W Sardinia, ever-grazed by beef cattle, to evaluate its strategic role in the sustainability of agro-forestry activities. The study was conducted between April 2011 and June 2012 in an experimental area of 24 ha, 670 m a.s.l., dominated by woody vegetation, mainly *Quercus pubescens* L. with an herbaceous cover limited to the glades.

Keywords: Sardinia, grazing value, sustainability, cattle-breeding, vegetation, High Nature Value Farmland, HNMF, habitat Nature 2000

Introduction

The protection of biodiversity is actually considered as a priority requirement for Nature conservation. With the adoption of 92/43/EEC Directive habitats, the European Community recognized the importance of biodiversity and contributes to its safeguard through the conservation of natural and semi-natural habitats and wild flora and fauna (Celada, 2003). In 1999 European Community has further recognized the importance of semi-natural pastures adopting EU 1257/99. The specific objective of the directive is the location and conservation of the European High Natural Value Farmlands, and to supply the normative tools for their correct management to preserve the biodiversity.

It has been well established that the maintenance of grassland communities in Western Europe depends on their management and that in grassland a moderate grazing by livestock contributes to the maintenance of plant diversity, by reducing the abundance of competitive dominant species (Klimek et al., 2007). The conservation of biodiversity, of landscape variety and of vegetation ecosystems is strictly linked to the prosecution of traditional agro-pastoral activities in Mediterranean area (Forconi V. et al., 2010; Klimek et al., 2007). Aim of this work was the ecological and vegetation characterization of a Sardinian marginal area and the evaluation of its strategic role in the sustainability of meat livestock production system.

Material and methods

Research area - The research was carried out between April 2011 and July 2012 in the experimental farm of Agris Sardegna, located in North-West Sardinia (lat 39°N, long 9 °E), at 670 m a.s.l.. The study area's surface is of 24 ha, grazed by cattle for 40 years, and it is characterized by a vegetation cover dominated by Mediterranean trees, 55% mainly Downy Oak (*Quercus pubescens* L.), and *Pteridium aquilinum* (L.) Kuhn, 24%, while the remaining patches are composed by rock (4%) and herbaceous cover.

The climate is Mediterranean with hot, dry, sunny summers and mild and rainy winters with some days of snow (Tmax = 28.1; Tmin = 3.3; total annual rainfall = 905 mm). For the phytoclimatic setting the area can be recognized (Farris et al., 2007) as belonging to the Mediterranean pluviseasonal oceanic bioclimate, inserted in the phytoclimatic belt *Upper Mesomediterranean* thermotype with an *Upper Subhumid* ombrotype and an *Euceanic* continentality. The soil of the area is of volcanic origin, clay-sandy with 5.5 pH.

Vegetation - A census of plant species was taken within the study site, over a 18 months sampling period, and it was used to assess chorological and biological spectra. Plants were classified following Pignatti (1997) and Arrigoni (2006 and 2010) and categorized to biological and chorological types (Pignatti, 1997). Endemisms and Species of Conservation Interest were then identified (Arrigoni et al., 1976-1991; Camarda and Valsecchi, 1983 and 1992; Gaminans and Marzocchi, 1996; Pignatti, 1997).



The research area was subdivided in five parts according to phytocoenosis and the homogeneity of landscape: oak wood (OW), glades with dominance of fern (FN), glades with no water seasonal stagnation (MD) characterized by meadows with dominance of *Trifolium* spp. and *Asphodelus microcarpus* Salzm. et Viv., glades with vegetation of wet meadows (WL), where water stands only during rainy seasons, rocky glades (RK), where rock covers more than 30% of the surface, with low soil and water stagnation plants.

Vegetation communities, grazing value and grassland's productivity were assessed within each one.

The grazing value was evaluated in each phytocoenosis during spring 2012, adopting the phytopastoral method of Daget and Poissonet (1971). The overall grazing value of the research area was obtained through the ponderal mean of the different grazing values. Ten transects of 20 m were used and 100 vertical point quadrates were taken in each transect, sampling every 20 cm. Specific indices were given as suggested by Cavallero et al. (1992), Roggero et al. (2002), Gusmeroli et al. (2007).

Biodiversity (Species Richness and Shannon index) was evaluated in each phytocoenosis adopting the phytopastoral relevés. Total species richness was calculated as the total number of species collected. Vegetation communities were observed at the end of spring 2012 and identified through 56 phytosociological surveys (Braun-Blanquet, 1951). The phytosociological data relating to cover, underwent multivariate analysis using Primer software. The syntaxonomy follows the criteria of Rivas Martinez et al. (2002), Bacchetta et al. (2004 and 2009), Farris et al. (2007) and Blasi et al. (2010). Phytosociological and census data were used to identify the presence of habitats of European importance included in 92/43/EEC Directive habitats (Biondi et al., 2010).

The biomass productivity was evaluated monitoring monthly herbage on offer (HO, t DM ha⁻¹) by cutting 84 stripes (0,10 m x 5 m), spread on all the experimental area. Sward height (SWH, cm) was also measured with weighted plate (150 records per ha). Data were analyzed with the GLM procedure of SAS using the phytocoenosis as fixed effect.

Livestock system - The research area was continuously grazed from April 2011 until July 2012 by twenty-four calves weaned at 6 month of age, 168.5 kg ± 16.2 Live Weight (LW, average ± st.dev.). The calves, divided in 4 groups [Sarda (S), castrated Sarda (Sc), Sardo-Modicana (SM) and F1 Charolaise bull X Sarda], received hay and concentrate as supplement since September 2011 (3,5 and 4,5 kg head⁻¹day⁻¹, respectively). Calf final live weight (LW, kg) was recorded and the Average Daily Gain (ADG, kg head⁻¹day⁻¹) was calculated. A sample of *Longissimus Dorsi* muscles was removed at 24 h post mortem after a refrigeration at 4±1 °C to evaluate pH and α tocopherol content (Panfili et al., 1994). LW were analyzed with the GLM procedure of SAS using the breed as fixed effect and the pre-experimental LW as covariate; ADG was analyzed with Mixed procedures of SAS using breed as fixed effect and animal as random effect. At the beginning of August 2012 half of S, Sc and F1 animals were slaughtered and their meat quality were assessed, while the other half was slaughtered after 6 months of fattening (data not shown).

Results

Vegetation characterization - A total of 252 species were recorded, referable to 46 families. Prevailing families are *Graminaceae* (19%), *Compositae* (13%), *Leguminose* (8%) and *Liliaceae* (6%). Chorological spectrum highlights the dominance of Euromediterranean (31%) and Stenomediterranean (31%) species, with a relevant percentage of Eurasians (17%). Endemisms and species of conservation interest represent 10% of total census. The prevalent Endemics are those with Sardinian-Corsican distribution and those with Sardinian-Corsican and Tuscan Archipelago distribution. The comparison of biological spectrum revealed the prevalence, including bulbous, of perennial species: the hemycryptophytes are 32% and geophytes 15%, while therophytes are 44%.

The biodiversity identified for each phytocoenosis is reported in table 1. The analysis of the phytosociological relevés has allowed the recognition of 7 syntaxa. Two of these syntaxa, *Ornithogalo pyrenaici-Quercetum ichnusae* Bacchetta, Biondi, Farris, Filigheddu & Mossa 2004 (*Quercus roboris-Fagetum sylvatica* class) and *Isoetion* Br.-Bl. 1935 (*Isoëto-Nanojuncetea* class), take up 58% of total research area surface and have permitted to recognize two habitats of European importance. They are the habitat 3130 - EUNIS Code C3.4 - "Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*" and habitat 91AA* - EUNIS Code G1.72- "Eastern white oak woods" subtype 41.72, characterized by Mediterranean and sub-Mediterranean Adriatic and Tyrrhenian woods with dominance of *Quercus virgiliana*, *Q. dalechampii*, *Q. pubescens* e *Fraxinus ornus*. The average grazing value of total research area is 25. The HO pick was recorded in Spring (1.16 and 0.98 t DM ha⁻¹, in



2011 and 2012, respectively), whereas in both Autumn and Winter the herbage on offer resulted very low (0.40 t DM ha⁻¹, Tab.1). The HO measured in autumn in OW (1.61±0.38 t DM ha⁻¹), because of the shedding of the Downy Oak leaves, and in FN, because of the great abundance of fern growing from late spring until autumn, resulted higher than the others (P<0.05).

Table 1: Biodiversity, grazing value (VP), total average herbage on offer (HO, t DM ha⁻¹) and sward height (cm) recorded in Oak Wood (OW), Fern (FN), Meadow (MD) and Wetland (WL) phytocoenosis during the trial (standard errors in bracket).

	OW	FN	MD	WL	RK
Species Richness	31	50	76	37	46
Shannon Index	4.2	4.4	5.4	4.3	4.5
VP	17	30	40	42	44
HO t DM ha ⁻¹	0.82 (0.07) b	1.73 (0.11) a	0.62 (0.03) c	0.49 (0.06) c	*nr
Sward height cm	3.4 (0.14) b	18.5 (1.76) a	5.0 (0.17) b	4.0 (0.64) b	*nr

*nr= not recorded; different letters within rows indicate statistical differences (P<0.05)

Livestock system - In table 2 animal performance are reported. The F1 group showed both higher live weight at slaughtering and growth rate than SC being the S group an intermediate. Any differences were detected in cold dressing percentage and meat quality. Ultimate pH is within the normal range, showing any of pre-slaughter stress. The meat showed α -tocopherol levels within the range needed to extend the shelf-life of retail beef (0.30-0.35 mg 100 g⁻¹ of fresh meat; Geay et al., 2001) and higher than that recorded in animal fed with hay and concentrate as reported by Acciaro (2013) in Sarda young bull and by Realini et al. (2004).

Table 2 : Live weight (kg), average daily gain (kg head⁻¹ day⁻¹), cold dressing percentage (%), meat pH and α tocopherol *L. Dorsi* muscle content of experimental animals (F1=Charolaise bull X Sarda, S=Sarda, SC=castrated Sarda)

	F1	SC	S
Live weights at slaughtering (kg)	382 a	325b	360 ab
Average Daily Gain (kg head ⁻¹ day ⁻¹)	0.508a	0.386b	0.480ab
Cold dressing percentage %	46.9	47.4	47.8
pH	5.78	5.77	5.89
α tocopherol	5.21	5.63	5.44

* different letters within rows indicate statistical differences (P<0.05).

Discussion and conclusions

The average daily gain of Sarda young bulls resulted lower than that recorded by Acciaro et al. (2011) in young Sarda beef cattle raised at pasture (0.780 ±0.06). Meat quality results good despite low production. The grass antioxidants cause in grazed animals higher muscles levels of α -tocopherol with benefit of lower lipid oxidation (Acciaro, 2013). The herbage availability, following the Mediterranean pattern, resulted different among the phytocoenosis and low if compared to the value reported from other authors in the same environment (Sitzia and Fois, 2008). This fact, together with the low dressing percentage recorded, confirms that forage production of the studied areas is unable to cover the growth requirements of animals. On the other hand vegetation analysis highlights an elevate natural value of the area proved by an high level of biodiversity and endemisms and species of conservation interest (10%). It is furthermore relevant that 58% of the study area surface is resulted occupied by two habitat of European interest. This fact underlines not only the natural value of marginal areas but also the importance of vegetation communities to identify the habitats of European importance and how 92/43/EEC Directive habitats could be an useful instrument to identify the High Natural Value Farmlands which European Community's States are undertaken to locate adopting EU 1257/99. These results show that the value of beef cattle farming system in marginal areas is not related only to the economic sustainability of the system but also to the provision of other services strictly linked to the quality of human life and nature conservation.



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