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Nutritive value of meadows in the Northeast of Portugal

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Abstract

Meadows continue to be the most important source of pasture and hay for beef cattle production in the hill and upland areas in the NE region of Portugal. The aim of this study was to evaluate CP contents and IVOMD values during the year, in three harvests (spring, hay cut and autumn) under the effect of three rates of N fertilisation in seven mountain meadows. The results showed that the highest CP and IVOMD occurred in the beginning of spring when meadows are in active vegetative growth. Effects of N fertilisation on CP and IVOMD occurred only in oligotrophic meadows, but in an irregular way, and mainly on IVOMD.

Keywords: nutritive value, nitrogen fertilisation, legumes, grasses, pasture

Introduction

Mountain meadows are an important source of feed for livestock in the NE of Portugal, especially when harvested as hay for the winter period. Adequate nutritive value of herbage is essential for a high rate of live weight gain and overall livestock performance. Pasture production and its nutritive value is determined by factors such as proportion of living and dead tissue, proportion of leaves *vs.* stems, as well as existing biodiversity between different species of plants (grasses and legumes). All these variables could vary between plant growth stages within a given growing season (Ball *et al*., 2001). Another factor that can change the quality of pasture is nitrogen fertilisation, because of its effect on the relative proportion of legumes and grasses in a pasture (Valencia *et al*., 2001) and this could reduce animal gains due to the generally lower feed value of grasses compared to legumes.

Material and methods

Seven meadows (M) reported in this paper (Table 1) were studied for crude protein content (CP), and digestibility (IVOMD) from 1998 to 1999. Three meadows were located in Vinhais/Bragança, which has long-term average annual rainfall of 741 mm, and four were located in Miranda do Douro, a more arid region (long-term annual rainfall of 554 mm). Meadows were subjected to three levels of N fertilisation (N0 = 0; N1 = 75 and N2 = 150 kg ha^{-1} y^{-1}), top-dressed when meadows were rested (March/April), after the usual winter/spring grazing period. The experimental design was a hierarchical completely random split-plot, where meadows were the main plots and N fertilisation the sub-plots. Three samples were harvested inside exclosure cages, with surface areas of 0.25 m×0.25 m, within sub-plots, at the beginning of spring (March/April), at the hay cut (June), and at the end of autumn (November/December). Samples were dried to constant weight at 60ºC (48 h). IVOMD was analysed by the Marten and Barnes (1980) method and the CP after macrokjeldahl digestion. CP content and IVOMD were considered as dependent variables, and M and N fertilisation as independent ones. Data

were analysed by PCA based on a correlation matrix for the dependent variables, followed by multivariate and univariate analyses of variance and mean separation (Tukey's HSD test).

Table 1. Meadow description. (G, L, O: percentage of grass, legume and other families in the first year during hay growth without N-fertilisation)

Meadow	Community	Environment	m a.s.l.	Region	G	L	O
M1	*Bromo-Cynosuretum cristati*	Eutrophic	820	Vinhais/Bragança	74	10	16
M2	*Anthemido-Cynosuretum cristati*	Mesotrophic	1060	Vinhais/Bragança	24	26	45
M3	*Gaudinio-Agrostietum cristati*	Mesotrophic	880	Vinhais/Bragança	48	6	46
M4	*Gaudinio-Agrostietum cristati*	Oligotrophic	750	Miranda do Douro	76	0	24
M5	*Bromo-Cynosuretum cristati*	Oligotrophic	750	Miranda do Douro	97	0	3
M6	*Genisto anglicae-Nardetum strictae*	Oligotrophic	820	Miranda do Douro	76	2	22
M7	*Bromo-Cynosuretum cristati*	Oligotrophic	670	Miranda do Douro	64	1	35

Results and discussion

PCA was significant ($P < 0.001$) in the explanation of dependent variables. The first axis (PCA1) (49% of total variability) illustrates the relationship between CP and IVOMD, and separated the meadows into two groups: (i) meadows with the highest CP and IVOMD values (M1, M2 and M3), and meadows with lowest ones (M4, M5 and M6) (Figure 1). In this last group, N fertilisation treatments had a significant effect on CP ($P < 0.01$) (Figure 2). In this case, the fertiliser rate (N1) had a reduced CP content compared to the high rate (N2) in M4 and M5, and compared to no fertilisation (N0) in M6.

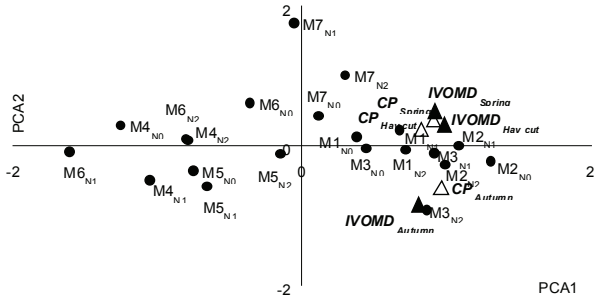

Figure 1. Loadings and scores of the two first PCA and significant effect of meadow type (M1-7). N0 = 0 kg N ha^{-1}; N1 = 75 kg N ha^{-1} and N2 = 150 kg N ha^{-1}

These results could be explained by the different floristic composition of meadows (Table 1), while M1, M2 and M3 had the highest proportion of legumes, and therefore, the highest CP and IVOMD values, M4, M5 and M6 had lower proportions of legumes, and consequently, the lowest CP and IVOMD. N2 fertilisation rate increased the proportion of grasses on meadows (unshown data), because legumes do not respond, or respond less, to N fertilisation (Sun *et al*., 2008).The results showed a significant effect ($P < 0.001$) of fertiliser treatments on IVOMD. IVOMD decreased on M6 (spring) and M7 (hay cut) when fertiliser (N1 and N2) was applied, while in M4 (spring) it increased IVOMD (Figure 2). N fertilisation greatly increases the CP content (Duru, 2003) and often, when N fertilisation increased, no changes or a decrease on herbage digestibility has been observed (Angell and Bailey, 1998). The second axis (PCA2) (18% of total variability) represented the variability of CP and IVOMD during the three harvests (Figure 1). In general, meadows had the highest nutritive values in spring (Figure 2),

when grasses were at the end of tillering and beginning of stem elongation, and the lowest values in the hay cut (flowering to ripening stages) and in the autumn, when the low mean temperatures (< 0ºC) led to minimal plant growth (< leaf ratio/stem ratio) and consequently, lower nutritive values (Mut *et al*., 2010), despite the tillering stage of grasses in this season.

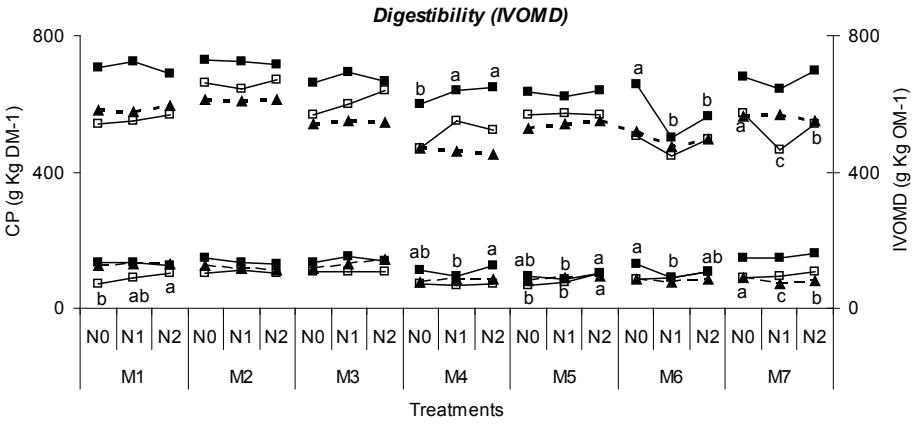

Figure 2. CP and IVOMD of meadows (M1-M7) in the three seasons and treatments. Different letters indicate significant differences between N treatments in the same harvest and meadow.

Conclusions

The nutritive value of meadows is in line with the type of plant communities and the agroecological potential of the environments where they are located (eutrophic, mesotrophic, and oligotrophic). The effect of N fertilisation on CP and IVOMD occurred only in oligotrophic meadows, but in an irregular way, mainly on IVOMD. CP and IVOMD are higher at the beginning of spring than in other seasons, even in autumn.

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