Session 21
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# COMPARATIVE STUDY OF HERBAGE NUTRITIONAL QUALITY BETWEEN MOUNTAINOUS GRASSLANDS IN NORTH WESTERN GREECE

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## Introduction

• Grasslands are complex ecosystems that form the backbone of profitable forage-livestock systems and contribute substantially to the agricultural economy (Sanderson et al, 2004). Grasslands cover approximately 40% of the total surface of Greece, occur in a great variety of habitats and characterized by considerable variability of species composition induced by climatic differences, adaptive advantages, bio-geographical influences and insularity (Karagiannakidou et al., 2001).

• Grassland nutritional quality is affected by abiotic and biotic environmental factors including soil type, climatic regime, botanical composition and range improvement practices (Pérez-Corona et al., 1998).

• The evaluation of feed quality is important for the prediction of animal performance (Tatli Seven and Çerçi, 2006). Herbage evaluation implies the description of feedstuffs with respect to their capacity to sustain diverse kinds and levels of production (Juárez et al., 2004). Thus, to improve the quality of the herbage consumed by grazing animals, it is necessary to obtain information over the chemical components of the feed in relation to their requirements.

## Objectives

• The objective of this study was to compare the variations in herbage production, chemical composition and dry matter digestibility, over a grazing period in two Greek mountainous grasslands in north-western Greece.

## Materials and Methods

(a) Study area

• The present study was conducted in two mountainous grasslands, on Mt Varnoudas, NW Greece (grassland 1) and in Epirus region W-NW Greece (grassland 2) (Fig.1), from May to October of the year 2008, which elevated 1250m a.s.l.

• The basic geological substrate of grassland 1 consists of phyllites, gneisses and micas shcists of the Pelagonic geotectonic zone, while that of grassland 2 consists of limestone.

• Mean soil pH was 5,33 and 6,96 in grasslands 1 and 2, respectively.

• Grassland 1 has a special climatic characteristic that approaches the middle – European type having as major characteristics a quite cold and damp winter and a rather dry summer. On the contrary, grassland 2 has a typical sub-Mediterranean climate (Table 1). The studied grasslands were covered by a great diversity of herbaceous species.

(b) Sampling and Experimental Analyses

• The experimental work was conducted the year 2008, during the grazing period (May to October) in Greek mountainous areas. In November of 2007 sixteen experimental cages (6 cages in grassland 1 and 10 cages in grassland 2), sized 4 m x 5 m, fenced with metallic net 1.5 m high in order to obstruct free – range grazing, were placed in preselected points of the grasslands.

• Each experimental cage was divided into 36 equal plots. Herbage biomass was collected at the beginning of each month, from 6 of the 36 equal plots in each cage, using a metallic quadrate equal to 1/36 of each cage. The herbage samples were clipped in situ at 2 cm above the soil surface using hand scissors (Odum, 1971). The harvested samples were handled carefully to avoid soil contamination and stored in paper bags.

• All samples were dried at 68ºC until constant weight, milled (1mm screen) and stored in glass vases. Herbage production was estimated as kg Ha-1 of dry matter (DM).

• Samples were analysed for Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and lignin content, according to Van Soest et al. (1991) method.

• Nitrogen (N) content was determined with copper catalyst Kjeldahl method 984.13 (A.O.A.C., 1995). Crude protein was calculated as N x 6.25.

• In vitro dry matter digestibility (IVDMD) was determined according to the two-stage method described by Tilley and Terry (1963), using rumen fluid from six fistulated sheep (body weight 48-49 kg).

• The data were analyzed statistically using the univariate Analysis of Variance (ANOVA) testing for the effects of the experimental area, sampling month and the "area x month" interaction, using the SPSS 12.0 software for Windows (Kitikidou, 2005).

## Results

• Herbage production showed a differentiation among subsequent or different months in both grasslands (Table 2). However the mean herbage production of grassland 1 was significantly lower than of grassland 2 (891,54±38,45 vs. 1760,07± 92,97 kg DM Ha-1). Herbage production was affected (P <0,001) by the area, sampling month and "area x month" interaction (Table 3). It was found a positive relation (P <0,01) between herbage production and experimental area (r= +0,718) (Table 4).

• In grassland 1, herbage NDF, ADF and lignin contents increased as the growing season progressed, showing a peak value during October. In grassland 2, respectively, the above mentioned contents increased up to August and then decreased till the end of the grazing period (Table 2).

• NDF affected (P <0,001) by the area, sampling month and "area x month" interaction (Table 3). ADF affected (P <0,001) by the area and sampling month while lignin affected (P <0,001) only by the sampling month (Table 3). It was found significant positive relation (P <0,01) between NDF and ADF (r= +0,776) as well as between ADF and lignin (r= +0,694) (Table 4).

• Herbage CP content showed similar fluctuation among subsequent months in both grasslands. Mean CP content of grassland 1 was 7,90 % DM while in grassland 2 was 12,20 % DM (Table 2). CP was affected (P <0,001) by the area, sampling month and "area x month" interaction (Table 3) and showed negative relation (P <0,01) to sampling month (r= -0,668) and lignin content (r= -0,602) (Table 4).

• IVDMD decreased during growing season in both grasslands. In grassland 1 IVDMD decreased about 32,88 % from May to October, while in grassland 2 IVDMD decreased about 37,93 % from May to September and then increased (Table 2). IVDMD affected (P <0,001) by the area, sampling month and "area x month" interaction (Table 3). It was found positive relation (P <0,01) between IVDMD and CP (r= +0,877) and negative between IVDMD and sampling month (r= -0,776) (Table 4).

## Discussion

• The present study showed that grassland 2 was about 97% more productive than grassland 1. Rain precipitation and air temperature (Table 1) probably explain this variation between grasslands. According to George et al. (2001) rain precipitation determines the beginning and the end of growing period of plants, while the air temperature usually determines the amount of aboveground biomass production during the vegetative period. The typical shape of grassland growth is a sigmoid curve, increasing to a maximum and then decreasing (Pérez-Corona et al., 1998). Herbage production followed this pattern in both grasslands.

• The herbage NDF, ADF and lignin contents were low for the first vegetative stages, in both grasslands. However, these contents increased significantly during the growing period, reaching their peak value at the end of growing season in grassland 1 and during August in grassland 2. According to Buxton and Redfearn (1997), the fibre content increases as plants mature, that is the most important factor affecting dry matter digestibility. The decrease of these contents in grassland 2 during autumn is probably explained by the regrowth of grassland plants.

• For all the herbage samples studied, the CP content was higher at the beginning of growing season (Table 3) during the initial leaf growth, accompanied by a high mitotic activity and a strong demand for nutrients, particularly nitrogen (Ammar et al., 2004). Thereafter, the CP content declined through the growing season, as a response to tissue ageing, particularly during the autumn, when nutrients are transferred to perennial tissues before abscission.

• For growing, free range, beef cattle that weigh approximately 200 kg, and have an average daily gain of 0.3-0.5 kg, the CP requirements for maintenance, comes up to 82 g kg-1 DM (or 8,2 % DM) (NRC, 1996). For ewes that approximately weigh 50 kg, the daily protein requirements for maintenance comes up to 95 g kg-1 DM (or 9.5% DM) (NRC, 1985). In grassland 2, beef cattle and sheep requirements were adequately covered during almost the total of grazing period. On the contrary, in grassland 1, beef cattle and sheep CP requirements were covered until mid-summer. For the rest of the period additional protein sources should be supplied in order to meet maintenance requirements of the grazing animals.

• In general, IVDMD showed a tendence to decrease progressively from spring to autumn in both grasslands. However, IVDMD in grassland 2 was higher than grassland 1, probably for the presence of more broadleaved plants in that area. According to Moreira et al. (2004), the higher the leaves proportion in the forage, the higher the CP contents and the lower the cell wall contents. The consequence will be more digestible forage. During the summer, leaf proportion in grasslands declined, so digestibility decreased during the summer. In the studied grasslands, IVDMD followed the same pattern

## Conclusions

• Native grasslands usually supply livestock with high food quality during spring but herbage quality declines rapidly as grazable material matures.

• Crude protein content was enough to cover the maintenance requirements of grazing beef cattle and sheep in grassland 2, while in grassland 1, ruminant requirements were covered only at the beginning of the growing season It was recommended that additional protein sources should be supplied in order to cover maintenance requirements of grazing beef cattle and sheep during the rest of the grazing period.

• Rational range management techniques are required to elevate the quantity and quality of herbage and maintain the traditional pastoralism in both grasslands.

*Table 1. Mean monthly air temperature (°C) and total rain precipitation (mm) of the experimental period*

| Month | ---- Air temperature (oC) ---- Grassland 1 | Grassland 2 | Month | ---- Rain precipitation (mm) ---- Grassland 1 | Grassland 2 |
|---|---|---|---|---|---|
| Jan | -2,4 | 3,1 | Jan | 3,8 | 115,3 |
| Feb | 0,3 | 4,0 | Feb | 19,4 | 121,0 |
| Mar | 5,4 | 5,8 | Mar | 41,2 | 120,3 |
| Apr | 8,3 | 9,0 | Apr | 44,4 | 78,0 |
| May | 12,6 | 15,0 | May | 27,6 | 46,1 |
| Jun | 17,0 | 16,9 | Jun | 39,4 | 88,5 |
| Jul | 19,3 | 21,6 | Jul | 6,4 | 3,1 |
| Aug | 20,4 | 20,3 | Aug | 2,0 | 11,8 |
| Sep | 13,1 | 12,4 | Sep | 93,0 | 57,0 |
| Oct | 9,1 | 9,6 | Oct | 24,4 | 105,6 |
| Nov | 4,7 | 8,4 | Nov | 35,6 | 130,2 |
| Dec | 0,1 | 6,8 | Dec | 72,6 | 150,7 |
| **Mean** | **9,0** | **11,1** | **Total** | **409,8** | **1027,6** |
| S.D. | 7,7 | 6,2 | S.D. | 27,3 | 47,4 |

*S.D.: Standard deviation*

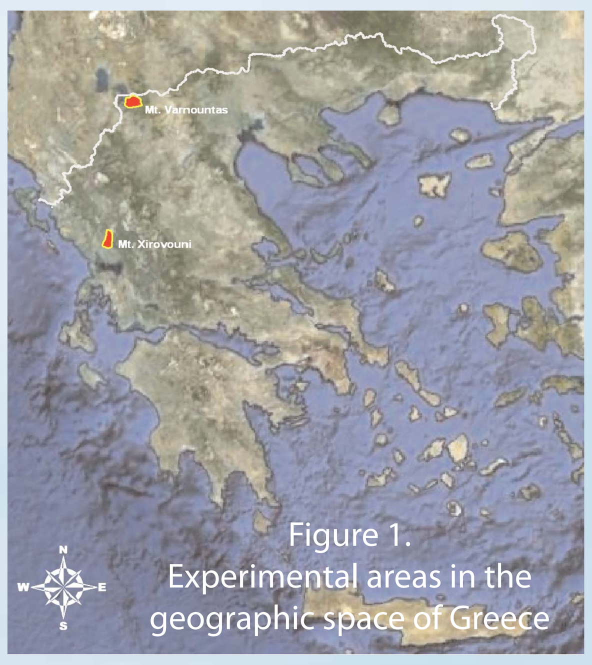


Figure 1.
Experimental areas in the geographic space of Greece

*Table 2. Monthly variations of chemical componets and in vitro dry matter digestibility (% DM) of herbage in grasslands 1 and 2*

| Parameter | n | Month: MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER | MEAN | S.E. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Grassland 1 | | | | |
| Production | 18 | 805,7 | 1100,77 | 938,13 | 818,33 | 911,3 | 775 | 891,54 | 38,45 |
| NDF | 18 | 49,24 | 58,95 | 58,3 | 59,4 | 60,55 | 65,18 | 58,6 | 1,32 |
| ADF | 18 | 30,33 | 35,01 | 36,21 | 38,94 | 38,76 | 43,47 | 37,12 | 1,11 |
| Lignin | 18 | 4,14 | 5,62 | 6,01 | 6,25 | 6,23 | 6,08 | 5,72 | 0,2 |
| CP | 18 | 11,48 | 9,05 | 7,2 | 6,36 | 6,51 | 6,81 | 7,9 | 0,46 |
| IVDMD | 18 | 62,43 | 48,3 | 54,62 | 46,25 | 47,55 | 41,9 | 50,17 | 1,85 |
| | | | | | Grassland 2 | | | | |
| Production | 30 | 1415,4 | 2211,2 | 2601,4 | 1691 | 1262,2 | 1379,2 | 1760,07 | 92,97 |
| NDF | 30 | 48,98 | 54,62 | 57,8 | 59,4 | 56,48 | 45,16 | 53,74 | 1,24 |
| ADF | 30 | 30,38 | 34,54 | 41,12 | 41,72 | 39,64 | 31,52 | 36,49 | 0,89 |
| Lignin | 30 | 4,22 | 5,16 | 6,02 | 7,04 | 6,9 | 6,08 | 5,9 | 0,2 |
| CP | 30 | 17,3 | 15,06 | 13,38 | 8,52 | 8,92 | 10,02 | 12,2 | 0,63 |
| IVDMD | 30 | 72,69 | 70,56 | 63,32 | 49,07 | 45,12 | 50,28 | 58,51 | 2,03 |

S.E.: Standard Error of Mean

*DM: Dry matter; NDF: Neutral Detergent fibre; ADF: Acid Detergent fibre; CP: Crude Protein; IVDMD: In vitri dry matter digestibility*

*Table 3. Influence (F-values) of sampling area and harvest month to the production, chemical components and in vitro dry matter digestibility of herbage in grasslands 1 and 2.*

| Factor | Area | Month | Area * Month |
|---|---|---|---|
| DM | 496,841*** | 41,847*** | 24,039*** |
| NDF | 13,905*** | 5,538*** | 5,766*** |
| ADF | 1,088 | 24,756*** | 15,805*** |
| LIGNIN | 1,39 | 23,719*** | 1,555 |
| CP | 257,330*** | 70,223*** | 8,416*** |
| IVDMD | 87,904*** | 67,342*** | 14,522*** |

*Level of significance: ***: P<0,001; **: P<0,01; *: P<0,05*

*DM: Dry matter; NDF: Neutral Detergent fibre; ADF: Acid Detergent fibre; CP: Crude Protein; IVDMD: In vitri dry matter digestibility*

*Table 4. Correlation coefficients of measured parameters*

| Parameter | Area | Month | DM | NDF | ADF | Lignin | CP |
|---|---|---|---|---|---|---|---|
| Area | 1 | | | | | | |
| Month | 0 | 1 | | | | | |
| DM | 0,718** | -0,231 | 1 | | | | |
| NDF | -,354* | 0,181 | -0,004 | 1 | | | |
| ADF | -0,065 | 0,449** | 0,128 | 0,776** | 1 | | |
| Lignin | 0,088 | 0,687** | 0,021 | 0,361* | 0,694** | 1 | |
| CP | 0,579** | -0,668** | 0,570** | -0,496** | -0,499** | -0,602** | 1 |
| IVDMD | 0,380** | -0,776** | 0,533** | -0,337* | -0,496** | -0,679** | 0,877** |

*Level of significance: *: P<0,05, **: P<0,01*

*DM: Dry matter; NDF: Neutral Detergent fibre; ADF: Acid Detergent fibre; CP: Crude Protein; IVDMD: In vitri dry matter digestibility*

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