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# Nutritive Value of Pastures in Kars District I. Botanical and Nutrient Composition at Different Stages of Maturity*

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**Abstract:** The objectives of this study were to examine the botanical composition and determine the nutritive value of pastures in 9 different locations in Kars district with respect to stages of maturity. Samples were collected bi-weekly from 21 May to 30 July 1999. The Gramineae, Leguminoseae and other plant families constituted 64.2, 22.8 and 13.0% of the plant population, respectively. There was a variation in the nutrient composition of samples collected from different locations ($P < 0.05$). Average dry matter (DM) content was 28.8% and concentrations of organic matter (OM), crude protein (CP), crude fiber (CF), neutral detergent fiber (NDF), nitrogen-free extract (NFE), ether extract (EE) and ash on a DM basis were 90.8, 15.3, 30.0, 57.6, 43.4, 2.0 and 9.2%, respectively. Stage of maturity altered nutrient composition ($P < 0.5$). Concentrations of OM, NFE and ash did not change, CP linearly decreased, and CF and NDF quadratically increased with advancing maturity. In conclusion, the Gramineae were the predominant flora of pastures in northeastern Turkey. Moreover, mathematical models developed to characterize changes in the nutrient composition of pastures with advancing maturity may help to improve current feeding strategies.

**Key Words:** Pasture, botanical composition, nutrient composition, stage of maturity, mathematical model.

## Kars Yöresi Çayır-Meralarının Besinsel Değeri I. Botaniksel Kompozisyon ve Farklı Olgunlaşma Dönemlerindeki Besinsel Bileşimi

**Özet:** Bu çalışma, Kars yöresindeki 9 farklı bölgenin çayır-meralarının botaniksel bileşimini ve farklı olgunlaşma dönemlerindeki besinsel değerini belirlemek için yapıldı. Örnekler 21 Mayıs ile 30 Temmuz arasında iki hafta aralıklarla toplandı. Bitki florası içinde buğdaygil, baklagil ve diğer familyalara ait bitkiler sırasıyla % 64,2, 22,8 ve 13,0 oranında bulundu. Çayır-meraların besin madde içerikleri örnek toplanan bölgeler arasında farklılık gösterdi ($P < 0.05$). Ortalama kuru madde (KM) içeriği % 28,8, organik madde (OM), ham protein (HP), ham selüloz (HS), nötral deterjan fiber (NDF), azotsuz öz madde (NÖM), ham yağ (HY) ve ham kül (HK) konsantrasyonları (KM bazında) ise sırasıyla % 90,8, 15,3, 30,0, 57,6, 43,4, 2,0, ve % 9,2 düzeyinde bulundu. Vejetasyon döneminin besin madde içerikleri üzerine etkisi önemli bulundu ($P < 0.05$). OM, NÖM ve HK konsantrasyonları bitkinin olgunlaşması ile değişiklik göstermezken HP doğrusal bir şekilde azaldı, HS ve NDF ise parabolik bir şekilde arttı. Sonuç olarak Kars ve yöresi çayır-meralarında buğdaygillerin en yaygın bitki örtüsü olduğu belirlendi. Ayrıca vejetasyonun ilerlemesi ile çayır-meraların besin madde bileşimindeki değişikliklere bağlı olarak yemleme şekillerinin iyileştirilmesine yönelik matematiksel modeller geliştirildi.

**Anahtar Sözcükler:** Çayır-Mera, botaniksel bileşim, besin madde bileşimi, olgunlaşma dönemi, matematiksel model.

## Introduction

Turkish livestock production is mostly based on small-scale family farming operations. In order to facilitate production efficiency, small herds are assembled during the grazing season in Kars district. Thus pastures are subjected to very intensive grazing by a number of animals over a limited grazing period (May, June and July) due to the short vegetation period. During the winter season, however, animals are fed diets solely consisting of hay produced from pasture. This feeding practice appears to be easy and economical for regional livestock production. The application of rotational grazing may not be feasible in northeastern Turkey because of the physical limitations mentioned. Moreover, the introduction of silage making from grass and the extensive use of silage may reduce feeding costs and,

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consequently, enhance production efficiency during the winter season. Although grasslands constitute 27.9% of the total land area of Turkey, estimates of total hay production range from 12 to 16 billon t per year (1-3). Thus evaluating the grazing system takes on a new degree of importance and, the need for the efficient utilization of pastures emerges.

Flora, stage of maturity, soil composition, climate, altitude and other managerial factors affect the physical and chemical properties of grassland (4-6). Grassland constitutes one third of Kars district (7), whose economy is heavily reliant on animal agriculture. Moreover, the determination of the botanical and nutrient compositions of pastures is essential for assessing nutrient intake and the economics of production. However, a limited number of studies concerning the agronomical characteristics of pastures from a nutritional standpoint in Kars district are available. Therefore, the objectives of this study were to examine the botanical composition and determine the nutritional value of grasses in Kars district with respect to stages of maturity.

## Materials and Methods

### Sample Collection

Representative pasture samples were collected bi-weekly from 9 different locations (Susuz, Burcalı-Arpaçay, Arpaçay, Akyaka, Dolaylı-Digor, Dağpınar-Digor, Selim, Söğütlü-Kars and Kars) during the vegetation period in the Kars district. The mean altitude of these locations ranges from 1500 to 2000 m and the average temperature is 10.1, 13.5, and 17.3 °C in May, June and July, respectively (8). An average of 6 sample collections at 14-day intervals were performed at each location from 21 May, 1999 to 30 July 1999. Ten subsamples obtained from 50 $cm^2$ isolated spaces in close proximity at soil level were harvested and then pooled to represent each sample by location.

### Analytical Procedures

Composites of subsamples were obtained from all locations only at the last harvest to characterize botanical structure. Samples were dried at room temperature without disturbing the original structure and then shipped to the Department of Horticulture, Faculty of Agriculture, Atatürk University, Erzurum, to determine their botanical composition. Samples obtained at all stages of maturity by location were analyzed to determine the nutritive value of the pastures. Nutritive value parameters included dry matter (DM), crude protein (CP), crude fiber (CF), neutral detergent fiber (NDF), ether extract (EE) and ash. Samples were dried at 60 °C for 48 h and then ground to pass through a 1 mm screen. Concentrations of DM, CP, CF, EE and ash were determined using the proximate analysis as outlined by AOAC (9), while concentrations of NDF were determined using the detergent system as described by Georing and Van Soest (10).

### Statistics

One-way analysis of variance with repeated measures was employed to determine the main effects of location and stage of maturity (time) and location by stage of maturity interaction on the nutrient composition of pastures using the general linear model procedure of Minitab (11). The structure of the linear model was as follows:

$$Y_{ij} = \mu + L_i + S_j + WPE + (LS)_{ij} + e_{ij}$$

where $Y_{ij}$ = response variable (nutrient composition), $\mu$ = population mean, $L_i$ = location (i = location 1, 2, 3, 4, 5, 6, 7, 8, 9), $S_j$ = stage of maturity (j = harvest 1, 2, 3, 4, 5, 6), WPE = whole-plot error, $(LS)_{ij}$ = $i^{th}$ location by $j^{th}$ stage of maturity interaction, and $e_{ij}$ = unexplained residual error, assumed to be normally distributed $N(i, j)$.

Since there was no significant effect of location by stage of maturity interaction, this term was omitted from the model. For botanical composition, the model included only the location effect because samples were obtained only at the final stage of maturity. In addition, mathematical models were developed to attain the maximum nutritive values in response to stages of maturity (12). Statistical significance was declared at a probability of less than 5% throughout the study.

## Results

### Botanical Composition

There was a variation in the botanical composition of pastures due to their location ($P < 0.05$). Since it was difficult to interpret the location effect on botanical composition, data were pooled to represent the Kars district. The Gramineae were the predominant plant type in pastures. The proportions of the Gramineae, Leguminoseae and other plant families were 64.2, 22.8, and 13.0% of the flora, respectively (Table 1).

Table 1. Botanical composition of pastures in Kars district.

| Gramineae (64.2%) | Leguminoseae (22.8%) | Other Families (13.0%) |
|---|---|---|
| *Phleum pratense* | Trifolium sp. | *Plantago lanceolata* |
| Agrostis sp. | *Medicago sativa* | Alyssum sp. |
| *Dactylis glomerata* | *Trifolium pratense* | *Artemisia spicigera* |
| Elymus sp. | *Lotus corniculatus* | Juncus sp. |
| Bromus sp. | Lathyrus sp. | *Achillea millefolium* |
| *Lolium perenne* | *Trifolium campestre* | *Convolvulus arvensi* |
| Festuca sp. | *Vicia sativa* | Taraxacum sp. |
| *Avena fatua* | | *Capsella bursa pastoris* |
| *Bromus japonicus* | | *Potentilla erecta* |
| *Festuca arundinacea* | | *Sanguiosorba minor* |
| | | *Plantago major* |
| | | Ranunculus sp. |
| | | Tragopogon sp. |
| | | Carex sp. |

### Nutrient Composition

Although the sites were in close proximity to each other, there was a great variation in the nutrient composition of the pastures, particularly of CP, NDF and EE ($P < 0.05$; Table 2). DM contents ranged from 25.0 to 32.8% and concentrations of OM, CP, CF, NDF, NFE, EE and ash on a DM basis ranged from 89.7 to 91.4, 12.3 to 16.7, 27.6 to 33.3, 53.4 to 61.2, 42.1 to 46.0, 1.6 to 2.5 and 8.6 to 10.3%, respectively. In the pastures of Kars district, average DM content was 28.8% and concentrations of OM, CP, CF, NDF, NFE, EE and ash on a DM basis were 90.8, 15.3, 30.0, 57.7, 43.4, 2.0 and 9.3%, respectively.

Stage of maturity affected DM concentration and concentrations of CP, CF, NDF and ether extract, but not OM, NFE or ash for pastures in the Kars district (Table 3). DM concentration decreased by the third harvest and then gradually increased by the end of the harvest season (Table 3). CP concentration linearly decreased and concentrations of CF and NDF quadratically increased as stage of maturity advanced (Figure). Concentrations of EE fluctuated according to stage of maturity (Table 3).

## Discussion

### Botanical Composition

Samples were harvested only at the final stage of the experiment in order to examine the botanical composition of pastures because the Gramineae bloom earlier than the Leguminoseae in a mixed flora setting (13). The Gramineae constituted approximately two thirds of the flora, followed by the Leguminosae, which constituted only one fifth of the flora (Table 1). In an earlier study conducted in a larger district area (Erzurum and Kars), it was reported that the proportions of the Gramineae and Leguminosae were 54 and 30%, respectively (14).

Table 2. Nutrient composition of pastures in Kars district.

| | | | Nutrients[1] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | OM | CP | CF | NDF | NFE | EE | Ash |
| Locations | n[2] | DM | % of DM | | | | | | |
| Susuz | 11 | 26.86 | 91.36 | 16.26 | 31.14 | 58.48 | 42.16 | 1.80 | 8.64 |
| Arpaçay | 6 | 25.03 | 89.69 | 15.57 | 28.18 | 58.26 | 44.38 | 1.55 | 10.31 |
| Burçalı/ Arpaçay | 5 | 27.99 | 91.28 | 15.33 | 30.73 | 59.03 | 43.01 | 2.22 | 8.72 |
| Akyaka | 10 | 31.08 | 90.54 | 15.65 | 29.00 | 55.87 | 43.72 | 2.16 | 9.46 |
| Dolaylı/Digor | 4 | 28.25 | 90.11 | 12.29 | 33.26 | 61.20 | 43.01 | 1.55 | 9.89 |
| Dağpınar/Digor | 5 | 32.83 | 91.01 | 13.63 | 29.34 | 56.84 | 46.04 | 2.00 | 8.99 |
| Selim | 11 | 31.69 | 91.18 | 14.66 | 30.88 | 60.56 | 43.57 | 2.06 | 8.85 |
| Söğütlü/Kars | 11 | 25.52 | 90.53 | 16.71 | 29.47 | 55.60 | 42.06 | 2.28 | 9.47 |
| Kars | 5 | 30.62 | 90.40 | 15.05 | 27.60 | 53.39 | 45.28 | 2.47 | 9.60 |
| Overall[3] | | 28.76 | 90.75 | 15.34 | 29.95 | 57.65 | 43.42 | 2.03 | 9.25 |
| SEM[4] | | 0.62 | 0.11 | 0.26 | 0.23 | 0.36 | 0.27 | 0.04 | 0.10 |
| P > F[5] | | * | * | * | * | * | * | * | * |

[1]Nutrients: DM = dry matter, OM = organic matter, CP = crude protein, CF = crude fiber, NDF = neutral detergent fiber, NFE = nitrogen free extract [NFE = OM – (CP + CF + EE)], and EE = ether extract. [2]n = number of sampling (replications). [3]Weighted least square mean. [4]SEM = standard error of a mean. [5]Probability of significance of location. * = ($P < 0.05$).

Table 3. Effect of stage of maturity on nutrient composition of pastures in Kars district.

| | | | | Nutrients[1] | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | OM | CP | CF | NDF | NFE | EE | Ash |
| Harvest No | Harvest Date | n[2] | DM | % of DM | | | | | | |
| 1 | 21 May | 13 | 26.87 | 90.63 | 20.45 | 24.66 | 50.12 | 43.67 | 1.85 | 9.37 |
| 2 | 04 June | 13 | 25.43 | 90.45 | 18.38 | 27.78 | 54.90 | 42.47 | 1.81 | 9.55 |
| 3 | 18 June | 13 | 25.58 | 90.65 | 15.96 | 30.10 | 57.73 | 42.60 | 1.97 | 9.35 |
| 4 | 02 July | 13 | 27.82 | 90.73 | 13.73 | 31.31 | 59.47 | 43.67 | 2.02 | 9.27 |
| 5 | 16 July | 12 | 34.11 | 90.35 | 11.90 | 32.29 | 60.93 | 43.95 | 2.21 | 9.65 |
| 6 | 30 July | 4 | 33.42 | 91.25 | 9.68 | 33.58 | 63.00 | 45.80 | 2.19 | 8.75 |
| SEM[3] | | 0.40 | 0.07 | 0.17 | 0.16 | 0.21 | 0.18 | 0.03 | 0.07 | |
| P > F[4] | | * | NS | * | * | * | NS | * | NS | |

[1]Nutrients: DM = dry matter, OM = organic matter, CP = crude protein, CF = crude fiber, NDF = neutral detergent fiber, NFE = nitrogen free extract [NFE = OM – (CP + CF + EE)], and EE = ether extract. [2]n = number of replications. [3]SEM = standard error of a mean. [4]Probability of significance of stage of maturity. * = (P < 0.05) and NS = not significant.

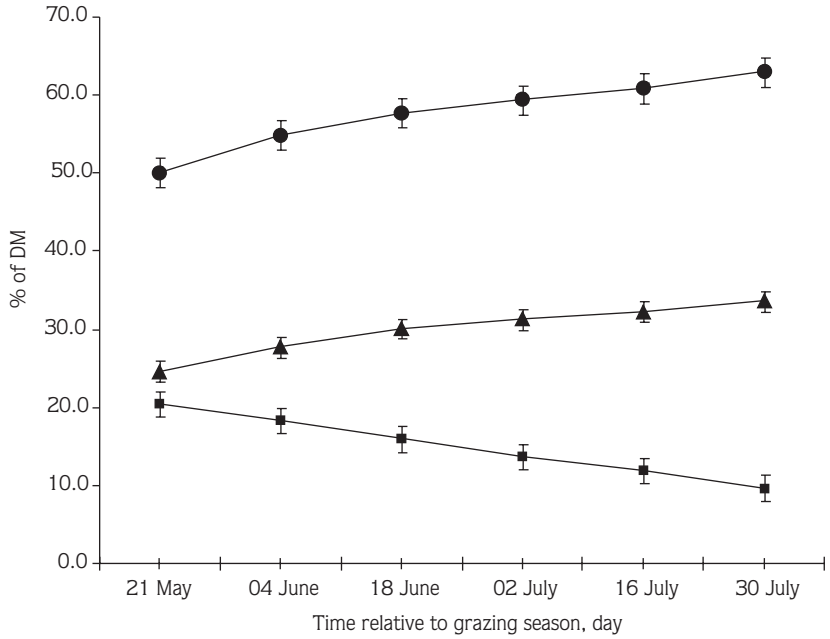


Figure. Changes in the nutrient compositions of pastures in Kars district with stage of maturity. Probability of significance for stage of maturity effect on concentrations of CP (■), CF (▲), and NDF (●) was less than 0.05. Day zero indicates initiation of the experimental period (21 May, 1999). Regression line was y = -2.16t + 22.57 with $R^2$ = 1.00 for CP, y = -0.34$t^2$ + 4.78t + 46.10 with $R^2$ = 0.99 for NDF, y = -0.26$t^2$ + 3.51t + 21.60 with $R^2$ = 0.99 for CF, respectively, where y = predicted corresponding response variable (CP, CF, NDF concentrations on a DM basis, % and t = time, day relative to grazing season).

Despite the statistical significance of location (Table 1), similar results from other districts of Kars reported by Dilmen (15) ascertain that the difference in botanical composition is numerically small and may be biologically negligible. Imbalance in the proportion of Gramineae and Leguminosae may adversely affect nitrogen fixation in the soil and, consequently, may reduce soil fertility and the nutritive value of pastures (16).

### Nutrient Composition

One would have expected no difference in nutrient composition due to the temporal correlations among

locations that are in close proximity (Table 2). Therefore, variation in nutrient composition is not explainable by our parameters and that could be related to differences in the botanical composition of the pastures mentioned earlier (Table 1).

There was a quadratic decrease in the DM concentration of the pastures (Table 2) as opposed to expectation that the concentration of DM linearly increases with advancing stages of maturity (4,17). Higher DM concentration at the first harvest compared with the 2 subsequent harvests could be a result of the consumption of young leaves by animals. At the third harvest and thereafter, the elevation of DM concentration could be attributed to plant maturation and cell wall lignification (4,17). Variation in the DM content of pastures within locations that were in close proximity was reported in similar types of surveys conducted in other parts of eastern Anatolia (18,19).

OM concentration on a DM basis was not affected by stage of maturity (Table 3). The average OM concentration was 90.8% for the whole district (Table 2), which is consistent with the results of other studies (20,21). The lack of a stage of maturity effect on ash concentration could be related to the lack of change in OM concentration by stage of maturity because OM concentration is inversely related to ash concentration. Average and range of ash concentrations reported in this study (Tables 2 and 3) were in agreement with the results of other surveys (19,20). Additionally, McDonald et al. (4) reported that ash concentration did not change with the progression of vegetation and that ash concentration ranged from 8.64 to 10.31%.

CP concentration decreased by 53% (from 20.5 to 9.7%) during the experimental period (Table 3 and Figure). The slope of the regression line ($y = -2.16t + 22.57$ with $R^2 = 1.00$; Figure) indicated that CP decreased 2.16% per day. Other reports also support that the concentration of CP decreases by advancing stage of maturity (19,20,22,23), suggesting that animals should be supplemented with protein sources, especially towards the end of the grazing season.

As expected, because of an overlap of the chemical constitutes of CF and NDF (24), increases in the pattern and magnitude of both nutrients by advancing stage of maturity were consistent (Table 3 and Figure). The second derivative of regression lines estimated that concentrations of CF ($y = -0.26t^2 + 3.51t + 21.60$ with $R^2 = 0.99$) and NDF ($y = -0.34t^2 + 4.78t + 46.10$ with $R^2 = 0.99$) reach a plateau at 6.77 and 7.05$^{th}$ harvest or on days 94.8 and 98.7 relative to the initiation of the experiment (21 May, 1999), respectively. Changes in both the magnitude and pattern of fiber concentration shown in the present study were in agreement with the results of other studies concerning changes in the dietary fiber content of feedstuffs with respect to stage of maturity (19,22,23,25). The effect of stage of maturity on NFE concentration was the opposite of that on NDF concentration (Table 3). This was expected, because the proportion of NDF in a typical ruminant diet is much greater than that of EE and CP and, consequently, NDF concentration is the major determinant for NFE concentration.

In general, the fat in forages comprises mainly galactolipids and the EE concentration does not change with advancing maturity (4). In this study, however, there was a linear increase in EE concentration, which is inconsistent with the literature (4,19). This inconsistency may be related to vegetation type.

In conclusion, this study showed that the Gramineae are the predominant plant population in Kars district and that CP concentration linearly decreased and CF and NDF concentrations quadratically increased during the short vegetation period. To improve production efficiency per acre, fields should be fertilized and/or animals should be supplemented with protein sources.

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