IN- VITRO DIGESTIBLE ORGANIC MATTER AND ENERGY CONTENTS IN WILD GROWING FORAGES OF ARMENIA

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ABSTRACT

Livestock production system in Armenia is based on forage plants derived from natural and modified pastures and hayfields. At present, because of the lack of a suitable laboratory base, local forages have not been investigated in terms of in-vitro digestible organic matter (IVD), gross energy (GE) and digestible energy (DE) values. This study was carried out in the UK Reading University using 110 herbage samples including 37 grasses, 60 legumes and 13 forbs. Samples were collected from the dry steppe (DS), meadow steppe (MS) and alpine (AL) zones of the Geghama Ridge and Mt. Aragats in Armenia. Mean organic matter (OM) content in different species varied within 880-936, IVD – 524-618, crude protein (CP) – 72-200 g/kg dry matter (DM), GE – 17.0-19.0 and DE – 9.5-11.2 MJ/kg DM. A substantial difference in OM, CP and GE contents was revealed between pure species and different botanical groups. Vertical zones also affected forage quality: the CP content increased in all forages and OM content fell in grass and legume forages with increasing elevations. In all zones studied legumes showed higher values of CP and DE than grasses and forbs.

Keywords: fodder plants, nutritive and energy values

INTRODUCTION

Armenia is a small highland country located in South Caucasus between 38°51'-41°20' N and 43°35'-46°30' E. Six altitudinal belts exist in the local mountain landscapes, from semi-desert (500-1200 m a.s.l.) to mountain tundra (> 3500 m a.s.l.). About 60% of agricultural lands consist of natural pastures and hayfields, which have historically played an important role in the national economy and in providing energy and nutrients for livestock production. The principal feedstuff used in the country is grass used in-situ by grazing and as air-dried hay derived from natural and artificially modified haymaking areas.

Uncontrolled grazing practices of domestic livestock have caused negative changes in plant communities and land degradation. As a result, the quality of natural pastures and hay-making areas is substantially decreased. Feed rationing system in Armenia is not established yet for the lack of sufficient information related to principal forage quality. So far, forage quality assessment in the country has been largely limited by measurements of crude protein, crude fat, nitrogen-free extractable substances and crude cellulose contents [1, 8]. Gross energy (GE), digestible organic matter content in the dry matter and digestible energy (DE) contents in local forages are not studied at all, because of lacking laboratory equipment.

Present study was carried out in the Nutritional Sciences Research Unit of the UK Reading University by the support of the UK Royal Society and NATO Expert Visit Program. The aim of this study was the preliminary assessment of nutritive and energy values of the forages derived from the natural pastures and hayfields of Armenia. The impact of vertical zones and plant species on forage quality is also considered in this paper.

MATERIAL AND METHODS

Sampling of forages was performed in the dry steppe (DS, 1250-1400 m a.s.l.), meadow steppe (MS, 1900-2400 m a.s.l.) and alpine (AL, 2700-3000 m a.s.l.) zones of the Geghama Ridge and Mt. Aragats during the years 2000 and 2002 at the flowering stage of the dominating plant species. One hundred and ten samples including 59 of pure grass and legume species and 51 mixed grass, legume and forbs species were collected (Table 1, 2). All samples were initially dried in the air and milled through 1mm screen. Before analysis they were dried for overnight at 105^{0}C to constant weight. Gross energy was measured using Parr 1281 bomb calorimeter (PARR Instrument Company, Moline, Illinois USA), nitrogen by Kjeldahl method, total organic matter (TOM) content by combustion of dried samples in a muffle furnace at 550°C overnight and in-vitro digestible organic matter content in DM (IVD) by the two-stage technique as described by Tilley and Terry [11]. Crude protein (CP) (g kg^{-1}) was calculated as the product of nitrogen (g kg^{-1}) * 6.25 and digestible energy (DE) (MJ kg^{-1} DM) content as gross energy (GE) (MJ kg^{-1} DM) * organic matter digestibility (OMD). The computer package was used to assess the differences between the mean values of chemical components, digestibility and energy content of the forages studied [9].

RESULTS

Table 1 presents the results of laboratory measurements of nutritive and energy values of some wild growing and cultivated forage species gathered from the DS zone of the Geghama Ridge. Within the grass species the highest TOM, IVD, DE and the lowest CP contents in DM were found in bromegrass (Bromus Danthoniae Trin) and meadowgrass (Poa bulbosa L.). Orchardgrass (Dactylis glomerata L.) held a mean position and aegilops (Aegilops squarrosa L.) was of the lowest quality except the CP content. The CP content in grass species did not show substantial variation. The wild growing legume forages were characterized by high nutritive and energy values, which are comparable with the cultivated alfalfa. Moreover, some of wild growing forms actually surpassed the cultivated alfalfa in some quality parameters (Table 1).

For example, the IVD content in wild growing vetch (Vicia sativa L.), white clover (Trifolium repens L.), bird's-foot (Lotus caucasicus Kurt.) and sweet clover (Melilotus officinalis (L) Desr.), the DE value in vetch, bird's-foot clover and sweet clover and the TOM content in bird's-foot and sweet clover were somewhat higher than those in the cultivated alfalfa. However, the CP content in cultivated alfalfa was higher as compared with the wild growing legumes with the exception of vetch. The data presented in Table 2 indicate that the mixed samples of different botanical groups differ substantially in the CP content, which was always higher in legumes than in grasses and forbs. The highest TOM content was found in grasses and the lowest TOM and GE contents in forbs. The studied parameters also varied on the grounds of vertical zones. With increasing vertical belts the CP content increased in all forages and the TOM content fell in grass and legume forages. In the mixed grass and forbs samples the highest values of IVD and DE were observed in the DS and MS zones, while maximum IVD in legume samples was found in the AL zone. Table 3 shows that the differences between botanical groups were more significant (A, B, C) than those observed within the same forage group derived from different vertical belts (D). The

Table 1. Organic matter and energy contents in forage species harvested from dry steppe zone

Plant species	Total organic matter (TOM)*	Digestible organic matter (IVD)*	Crude protein (CP)*	Gross energy (GE)**	Digestible energy (DE)**
Grasses:					
Aegilops (3)	914	557	77.6	17.0	9.5
Brome grass (8)	933	598	72.0	17.9	10.7
Orchard grass (4)	929	584	79.2	18.3	10.7
Meadow grass (3)	936	592	73.5	18.6	11.0
Legumes:					
Bird's-foot (2)	927	585	155	19.0	11.1
Alfalfa (6)	912	569	181	18.6	10.6
Sweet clover (3)	926	583	151	18.7	10.9
White clover (7)	912	602	152	18.1	10.9
Sainfoin (4)	918	569	172	18.4	10.5
Vetch (7)	918	618	186	18.2	11.2
Alfalfa cultivated (12)	913	573	181	18.7	10.7

Numbers in parentheses indicate replications of analysis
in g/kg DM; ** in MJ/kg DM

Table 2. Organic matter and energy contents in mixed forage samples harvested from different vertical zones

Zone, botanical group	Total organic matter (TOM)*	Digestible organic matter (IVD)*	Crude protein (CP)*	Gross energy (GE)**	Digestible energy (DE)**
Dry steppe zone (1250-1400 m a.s.l., samples were harvested in 2000)					
Grass (17)	930	587	74.6	18.0	10.6
Legume (42)	915	586	173	18.5	10.8
Meadow steppe zone (1900-2400 m, samples were harvested in 2002)					
Grass (10)	922	560	102	18.0	10.1
Legume (8)	911	573	187	18.1	10.4
Forbs (8)	880	577	127	17.5	10.1
Alpine zone (2700-3000 m, samples were harvested in 2002)					
Grass (10)	914	524	135	18.4	9.6
Legume (10)	901	595	200	18.2	10.8
Forbs (5)	893	546	149	17.9	9.7

Numbers in parentheses indicate replications of analysis
* in g/kg DM; ** in MJ/kg DM

most significant difference between botanical groups was established in CP and total OM contents (six comparisons out of seven). Forage species differed significantly also according to the GE value (significant difference was observed in four out of seven comparisons). The least significant difference was recorded in the IVD and DE values: IVD content was significantly different between grass and legumes (AL zone) and grass and forbs (MS zone). Grass and legumes grown both in the DS and AL zones also differed substantially according to DE value. In addition, significant differences in the CP content were recorded between the grass samples harvested from MS and AL zones (Table 3, D). Vertical zones (MS vs. AL) also significantly affected the GE content of forbs.

DISCUSSION

The studied wild growing forage plants (Table 1) were not long ago ranked among the most abundant species of the natural pastures located in the DS zone of Armenia, but now most of them are threatened with disappearance. Our recent investigations have shown [5] that the production of legume forages in an intensively grazed natural pasture located in the DS zone of the Geghama Ridge constituted less than 1% of total above-ground biomass. However, in many moderately grazed pastures these legume species still grow quite abundantly, so they might be cultivated and used for the improvement of the eroded lands. These forages are poorly studied in terms of chemical composition [1] and the IVD, GE and DE are not studied at all. It is interesting to know whether our data on CP and IVD in pure forage species agree with those obtained in other countries. According to the study [4] carried out in Pennsylvania, USA the CP in orchardgrass (Dactylis glomerata L) and in smooth bromegrass (Bromus inermis Leyss) varied within 123-172 and 128-190 g/kg DM and the IVD within 580-673 and 595-691 g/kg DM. CP and IVD in alfalfa (Medicago sativa L.) grown in the UK varied from 156-268 and 522-590 g/kg DM, respectively [12] and on the tropical island of Puerto Rico the mean values of CP and IVD in this species were respectively 220 and 686 g/kg DM [7]. The CP content in alfalfa grown in Canada was 178-187 g/kg DM [6] and in white clover (Trifolium repens L.) grown in Australia [10] from 177 to 277 g/kg DM. The comparison of these data with those presented in Table 1 shows that both CP and IVD contents in local wild growing forages were substantially lower than those obtained in other countries except for the CP content in the Canadian alfalfa and IVD in the UK alfalfa [6, 12]. As

Table 3. Significance of differences found in nutritive value of forages grown in the mountain grasslands of Armenia

Parameters compared	Total organic matter (TOM)*	Digestible organic matter (IVD)*	Crude protein (CP)*	Gross energy (GE)**	Digestible energy (DE)**
I. Difference between botanical groups grown within the same zone					
A. Grass vs. legume grown in zones:					
Dry steppe (59)	***	ns	***	***	*
Meadow steppe (18)	*	ns	***	ns	ns
Alpine zone (20)	*	*	**	ns	*
B. Grass vs. forbs grown in zones:					
Meadow steppe (18)	***	*	*	*	ns
Alpine (16)	**	ns	ns	*	ns
C. Legume vs. forbs grown in zones:					
Meadow steppe (16)	***	ns	***	*	ns
Alpine (16)	ns	ns	*	ns	ns
II. Difference between the same botanical group grown in different zones					
D. Meadow steppe zone vs. alpine zone					
Grass (20)	ns	ns	**	ns	ns
Legume (18)	ns	ns	ns	ns	ns
Forbs (13)	ns	ns	ns	*	ns

Numbers in parentheses indicate replications of analysis.
ns – P > 0.05 (not significant); * - P < 0.05; ** - P < 0.01; *** - P < 0.001.

it was stated above, the principal feedstuff in Armenia is the mixed forage derived from the mountain grasslands, which differ substantially in their nutritive value (Table 2). As shown on Table 3, both botanical groups and vertical zones significantly affect the quality parameters studied. This is in agreement with the studies carried out by Givens et al. [3], Corona et al. [2], and Stockdale [10] indicating that chemical composition, DM digestibility and energy value of forages varied significantly according to herbage variety, growth stage, year of harvest and vertical belts. In addition, our findings on CP and IVD contents in mixed forages are generally comparable with the published data. For example, analytical data presented in UK tables [12] show that in grass hay the CP content in 128 samples varied from 52 to 199 (mean 107) g/kg DM and IVD from 278-801 (mean 584) g/kg DM. In the study carried out in Spain [2] the CP in mixed samples of grasses, legumes and forbs varied within 72-89, 143-155 and 90-103 g/kg DM and IVD within 624-652, 612-651 and 602-634 g/kg DM respectively.

CONCLUSION

This study is the first attempt to characterise in-vitro digestible organic matter, gross and digestible energy values of local forage plants of Armenia. It has been revealed a wide range variation in nutritive value of different botanical groups implying different capability to meet nutritional requirements of livestock. The mean values of parameters regarding mixed grass, legume and forbs are generally comparable with the published data.

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