academicJournals

Vol. 9(8), pp. 746-749, 20 February, 2014
DOI: 10.5897/AJAR2013.7805
ISSN 1991-637X ©2014 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Chemical composition and relative feed value of three Mediterranean fodder shrubs

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Accepted 29 January, 2014

This study was conducted to compare forage quality of three dominant Mediterranean species (*Haloxylon schmittianum*, *Anabasis articulata, Astragalus armatus)* in a semi-arid rangeland, Tebessa, east of Algeria. The shrubs were hand harvested at the flowering stage. Chemical composition includes: Crud protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), ether extract (EE), ash. Dry matter digestibility (DMD), relative feed value (RFV), dry matter intake (DMI) and metabolisable energy (ME) were calculated. CP, ADF, NDF, Ash and EE contents ranged from 12.22 to 17.13%, 24.78 to 30.01%, 41.13 to 44.67%, 9.09 to10.26% and 2.61 to 3.43%, respectively. The digestibility DM, DM intake and RFV ranged from 65.52 to 69.59%, 2.68 to 2.90% and 136.11 to 154.48%, respectively. The NDF, ADF contents of *A. armatus* was significantly higher than those for *H. schmittianum* and *A. articulata* ($P < 0.05$). The DMD and RFV of *H. schmittianum* are significantly higher than those for *A. articulata* and *A. armatus.* The DMI in *H. schmittianum* was significantly higher than those for other shrubs. The ME contents of *H. schmittianum* was significantly higher than that for *A. armatus.* The species studied offered considerable potential as high quality forage for ruminants during the critical periods of the year when the quality and quantity of pasture herbages are limited.

Key words: Relative feed value, dry matter intake, digestibility, Mediterranean shrubs, semi-arid rangeland.

INTRODUCTION

In Algeria, livestock production plays a major role in national economy through provision of animal products for local consumption and foreign exchange; most of the livestock are kept under extensive management system and are fed exclusively on rangeland resources. Trees and shrubs are important sources of feed for ruminants, particularly in areas with long dry period and harsh environmental conditions as the Mediterranean regions, despite the fact that, their feed quality is not as high as that of herbaceous species (Papanastasis et al., 2004).

In the semi-arid areas of Algeria, where forage availability and quality are often limited due to low rainfall and drought conditions, shrub fodders are important in providing nutrients for grazing ruminants. Some desert shrubs, such as *Haloxylon schmittianum, Astragalus armatus and Anabasis articulata*, are important for animal production owing to their potentially good nutritive values. The value of these plants in animal nutrition is associated with features such as its abundant supply. Additionally, the mentioned species are widespread in the areas where livestock production is a crucial source for farmers' income, in contrast to annual plants that generally have shorter growing periods and lower yields (Gokkuş and Koc, 2001).

Among various common chemical determinations of plant materials, CP, DMD, and ME are mainly considered

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Table 1. Legume, grass and legume-grass mixture quality standards.

[a] Quality standard	CP% of DM	ADF, % of DM	NDF, % of DM	[b] RFV
Prime	19<	31>	40>	151<
1	19-17	40-31	46-40	125-151
2	16-14	40-36	53-47	103-124
3	13-11	42-41	60-54	87-102
4	10-8	45-43	65-61	75-86
5	8>	45<	65<	75>

[a]Standard assigned by Hay Market Task Force of American Forage and Grassland Council [b] Relative Feed Value (RFV)- Reference hay of 100 RFV contains 41% ADF and 53% NDF.

for evaluation of forage quality (Arzani et al., 2004). Because of its close association with animal productivity, digestibility is frequently considered to be the most valuable estimate of forage quality (Walton, 1983). However, information about RFV for shrubs such as *H. schmittianum, A. armatus and A. articulata* are in existence in Algeria.

The present study was therefore undertaken to explore nutrient contents and RFV of these three Mediterranean fodder shrubs available in the eastern part of Algeria, region of Tebessa. This region is characterized by open vegetation cover, dominated primarily by perennial shrubs and a variety of small graminaceous species. Therophytes and chamaephytes are the dominant life forms in this area. The experimental shrub species were selected because they are abundantly available and highly preferred by ruminants (sheep, goats and camels) in its natural habitat and because farmers strongly believe that these foliage species are highly nutritious.

MATERIALS AND METHODS

Description of the study site

The study site is a semi-arid zone located on the southeast of Algeria, region of Tebessa (34°28'59'' N and 7°31'0'E). The trial was carried out during the period of April 2012, at flowering stage. This region is characterized by altitude level of 316 m, with a typical Mediterranean climate. The coldest month is December, with occasional freezing (down to -2°C) in January and February. The period between July and August is the hottest, sometimes extremely hottest of the year, during which temperatures can reach as high as 46°C (in the shade). The rainfall is characterized by low averages, high irregularity and torrential downpours. Generally, the region receives annual rainfall of between 100 and 300 mm.

Chemical analysis

Before analyses, the samples were dried for 48 h at 60°C and then weighed and grounded in a hammer mill, provided with a 1 mm pore size screen. The chemical analysis of plants was performed according to the methods of the Association of Official Analytical Chemists (AOAC, 1990). The dry matter (DM) content of plants was determined by drying to constant weight at 105°C, and ash after heating at 550°C until a constant weight was reached. Nitrogen (N) content was measured using the Kjeldahl method. The CP was calculated as N×6.25, ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) determined according to (Van Soest et al., 1991).

Relative feed value

Relative feed value (RFV), (Table 1) was calculated from the estimates of dry matter digestibility (DMD) and dry matter intake (DMI) (Rohweder et al., 1978): DDM % = 88.9 - (0.779 × %ADF), DMI % of BW = 120 / %NDF, RFV = (%DDM × %DMI) /1.29, ADF: acid detergent fibre (% of DM), DMI: Dry matter intake (% of Body Weight).

Dry matter digestibility values were used to estimate digestible energy (DE, kcal/kg) using the regression equation reported by Fonnesbeck et al. (1984): DE (Mcal/kg) = 0.27 + 0.0428 (DMD %). Then DE values were converted to ME using the formula reported by Khalil et al. (1986): ME (Mcal/kg) = 0.821×DE (Mcal/kg).

Statistical analysis

Different experimental groups (constituents and parameters) were compared with the Univariate ANOVA followed by Bonferroni's test for comparisons post hoc. A probability level of $P \leq 0.05$ was considered to be statistically significant. The SPSS software package (SPSS Ver. 15.0, SPSS Inc., Chicago, Illinois) was used for all tests.

RESULTS AND DISCUSSION

Dry matter content ranged from 89.41% in *H. schmittianum* to 91.38% in *A. armatus* (Table 2). Crude protein content of shrubs species ranged from 12.22 to 17.13% (Table 2). Ash value ranged from 9.09% in *A. armatus* to 10.26% in *A. articulata*. The ash content of *A. articulata* was significantly higher than those for the other shrubs ($P < 0.05$). The highest ether extract content was recorded for *H. schmittianum* (3.43%), while *A. armatus* showed the least value (2.61%). Although, there were no significant differences among species in terms of EE ($P>0.05$), the EE content of *A. armatus* was lower than those for the other shrubs. Similar variations in chemical composition have been reported for some fodder trees and shrubs of Algerian arid and semi-arid areas (Bouazza et al., 2012).

Table 2. The chemical composition of shrubs sampled at flowering stage.

Constituent	*Haloxylon schmittianum*	*Anabasis articulata*	*Astragalus armatus*	SEM	Sig
DM	89.41[a]	90.60[a]	91.38[a]	0.894	NS
CP	14.18[a]	17.13[b]	12.22[c]	0.422	***
EE	3.43[a]	3.35[a]	2.61[a]	0.379	NS
Ash	9.30[a]	10.26[b]	9.09[ac]	0.310	NS
NDF	41.77[a]	43.43[b]	44.67[c]	0.035	***
ADF	24.78[a]	26.91[a]	30.01[b]	0.831	***

Row means within common superscript do not differ (P>0.05); *** P<0.05, NS: Non significant. SEM: Standard error, Sig: Significance level, DM: dry matter (%), CP: Crude protein (%), EE: ether-extract (%), NDF: Neutral detergent fiber (%), ADF: Acid detergent fiber (%).

Table 3. The dry matter digestibility, dry matter intake and relative feed value of shrubs sampled at flowering stage.

Parameter	*Haloxylon schmittianum*	*Anabasis articulata*	*Astragalus armatus*	SEM	Sig
DMD	69.59[a]	67.93[b]	65.52[c]	0,354	***
DMI	2.90[a]	2.76[a]	2.68[a]	0,085	NS
RFV	154.48[a]	145.65[b]	136.11[c]	0,575	***
ME	2.66[a]	2.60[a]	2.52[a]	0,201	NS

Row means within common superscript do not differ (P>0.05); *** P<0.05; SEM: Standard error; Sig: Significance level; DMD: dry matter digestibility (%); DMI: Dry matter intake, (%) of Body weight; RFV: relative feed value; ME: metabolisable energy (Mcal/kg).

There were significant differences between CP contents of shrub species (P < 0.05). The minimum CP content (Table 2) was recorded for *A. armatus* and the maximum CP was obtained with *A. articulata.*

A. armatus is commonly used as spring pastures by camel producers. The results show that this plant has a medium CP content, slightly greater than values observed for the same plant species collected from Algeria rangelands (Boufennara et al., 2012). The CP content of the shrub species studied herein was always higher than the minimum level of 7-8% DM required for optimum rumen function and feed intake in ruminant livestock (Van Soest, 1994).

The NDF and ADF content (Table 2) ranged from 44.67 to 41.77% and 30.01 to 24.78%, respectively. The NDF content of *A. armatus* was significantly higher than those for *A. articulata* and *H. schmittianum.* The ADF content of *H. schmittianum* was significantly lower than those for *A. armatus* and *A. articulata* (P < 0.05).

These results are in line with the findings of Bouazza et al. (2012) and Kokten et al. (2012) who indicated that cell wall content (NDF and ADF) increased with advancing maturity.

Our NDF and ADF values are similar to those reported for other Mediterranean shrubs (Frutos et al., 2002; Ammar et al., 2004), with some differences among all studies, probably because of the different proportions of foliage and twigs in the samples and the different phenological stages of the plants at sampling.

Estimated parameters (DMD, DMI and RFV) of the selected species ranged from 69.59 to 65.52%, 2.9 to 2.68% and 154.48 to 136.11, respectively (Table 3). The DMD and RFV of *H. schmittianum* were significantly higher than those for *A. armatus* and *A. articulata* (P < 0.05). However, DMI was ranged from 2.68 to 2.90 of body weight. DMI did not differ significantly between the three fodder shrubs.

The ME value of fodder shrubs ranged from 2.66 to 2.52 Mcal/kg. The ME value did not differ significantly between the studied shrubs (P>0.05).

The DMD of *H. schmittianum* and *A. articulata* was considerable higher than that of some legume hays harvested at flowering stage obtained by Kiraz (2011). The difference between these studies was possibly due to the high level of fibre content in shrubs species.

Generally, about 50% digestibility is sufficient for animal maintenance (Victor, 1981). The ME ranged from 2.66 to 2.52 Mcal/kg dry matter. *A. armatus* had the lowest ME, while *H. schmittianum* had the highest value. There were no large variations between ME content of the three fodder shrubs and no significant differences.

The ME content of the three shrubs studied was considerably higher than that reported by Juarez-Reyes et al. (2004) who found that ME content of forage in Mexico was 2.01 Mcal/kg. The difference between these studies is possibly due to difference in stages of growth

and environmental conditions.

Conclusion

The three shrubs investigated in this study showed high contents of RFV, CP, ME, and DMD. Based on these nutritional indices, it could be concluded that the fodder shrubs were consistent with the requirement proposed by Hay Market Task Force of American Forage and Grassland Council. The examined shrubs might provide a considerable part of animal demands for energy and protein, and thus, offering considerable potential as high quality forage for ruminants during critical periods in the semi-arid regions of Algeria.

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