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Rumen degradability of some Algerian browse plant species from Algerian arid rangelands

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Abstract. The study was conducted in Boussâda district, in the arid Saharan Atlas region with the objective of evaluating the chemical composition and *in situ* rumen degradation of Algerian browse plants collected from arid rangelands. Six browse plant species were used in this study: four dicotyledon plants namely *Atriplex halimus*, *Artemisia herba-alba*, *Astragalus gombiformis* and *Calobota saharae* and two monocotyledon plants, namely *Lygeum spartum* and *Stipa tenacissima*. Nylon bags containing foliage samples of each species were incubated for 0, 24 and 96 h (as indicators of solubility, degradation rate and potential degradability of the forages) in the rumen of three Merino sheep fitted with rumen fistula. Forages showed different (P<0.001) DM and NDF dissapearance rates. After 96 hours of incubation time, the highest *in sacco* DM disappearance was observed for *A. gombiformis* (0.85 g/g DM incubated) and the lowest was obtained with *S. tenacissima* (0.31 g/g DM incubated). In summary, dicot plants with high protein, low fiber and high DM ruminal degradability could be regarded as interesting roughages for use as ruminant feedstuffs.

Keywords. Algerian arid areas – Browse plants – Chemical composition – Nutritive value – Rumen.

Dégradabilité ruminale de plantes Algériennes collectées dans les régions arides

Résumé. *Cette étude a été menée dans la région de Boussâda avec pour objectif l'analyse chimique et l'évaluation de la dégradation* in sacco *de plantes algériennes. Quatre plantes dicotylédones:* Atriplex halimus, Artemisia herba-alba, Astragalus gombiformis, Calobota saharae *et deux plantes monocotylédones:* Lygeum spartum *et* Stipa tenacissima *sont utilisées. Des sacs en nylon contenant un échantillon de chaque substrat sont incubés à 0, 24 et 96 h (comme indicateurs de solubilité, taux de dégradation et potentiel de dégradabilité des fourrages) dans le rumen de trois moutons de race Mérinos munis de fistules. Les disparitions* in situ *de la matière sèche (MS) et des parois végétales totales (NDF) ont été significativement différentes entre les fourrages (P<0.001). Aprés 96 heures d'incubation, la disparition* in situ *de la MS la plus élévée est observée pour* A. gombiformis *(0.85 g/g MS) alors que la valeur la plus faible est obtenue pour* S. tenacissima *(0.31 g/g MS). En conclusion, les plantes dicotylédones avec un contenu élevé en protéines, une faible concentration en fibres et une bonne dégradabilité ruminale, peuvent être envisagées comme des plantes intéressantes pour l'alimentation des ruminants.*

Mots-clés. *Composition chimique – Plantes – Rumen – Valeur nutritive – Zones arides algériennes.*

I – Introduction

The hill areas of northern atlas Algerian region have traditionally been used to rise sheep and goats, which can browse substantial amounts of shrubs to meet their nutrient requirements. Forages are the major and cheapest source of energy for ruminants. Improvement in forage fibre digestion

increases the energy available to ruminants (Jalilvand *et al*., 2008). Despite their potential as feeds, little research has been completed to determine their nutritive value.

The *in situ* rumen disappearance and *in vitro* gas production techniques are useful for rapid screening of feeds to assess their potential as energy sources for ruminants (Preston, 1995). The gas production technique has proved to be more sensitive than the *in situ* nylon bag technique for determining the nutritive value of feeds containing inhibitory compounds, such as tannins. Khazaal *et al.* (1994) showed that physical binding of tannins to substrate could be detected in a nylon bag incubated in the rumen, although effects such as toxicity to microbes and binding to enzymes would be diluted and difficult to detect.

The objective of this study is to evaluate the nutritive value of various shrub species by determining chemical composition and *in situ* dry matter and NDF disappearances of these forages.

II – Materials and methods

Plant material was collected in Bousâada district, north central Algeria (N 35° 15.768', E 04° 13.885', 496-981 m altitude), in the Saharan Atlas region. Six browse plant species were used in this study: four dicotyledon plants namely *Atriplex halimus* L., *Artemisia herba-alba* Asso, *Astragalus gombiformis* Pomel and *Calobota saharae* (Coss. & Durieu) Boatwr. & B.-E. van Wyk (formerly *Genista saharae* or *Spartidium saharae*) and two monocotyledon plants, namely *Lygeum spartum* Loefl. ex L. and *Stipa tenacissima* L. Samples were collected when plants were at a flowering (*A. halimus, A. gombiformis* and *L. spartum*) or at a mature stage (the rest of species). Between six and ten specimens of each plant species were sampled to obtain a representative aliquot of the edible biomass, taken to the laboratory, pooled, oven-dried at 50ºC (Makkar, 2003), and ground to pass a 1 mm screen.

The procedure to measure *in situ* disappearance has been described in detail by López *et al*. (1999). *In situ* DM and neutral detergent (NDF) degradability in the rumen of each browse species was determined as the DM and NDF disappearances when samples (3 g DM) weighed in nylon bags (45 µm pore size and 7.5 x 15 cm size) were incubated in the rumen of three fistulated Merino sheep (body weight 49.4 ± 4.23 kg) for 24 and 96 h (3 bags per sample and incubation time, one in each sheep). At the end of incubation, bags were removed from the rumen, rinsed with cold tap water and washed in a washing machine with cold water for 3 cycles of 3 min each. The washed bags were dried in a forced draft oven at 100ºC for 48 h, and the residual DM used to calculate DM and NDF disappearances at each incubation time. Two bags per sample were washed following the same procedure without being previously incubated in the rumen to estimate DM disappearance at 0 h.

One way analysis of variance (Steel and Torrie, 1980) was performed on *in situ* data, with browse species as the only source of variation (fixed effect) and sheep (random effect) as a blocking factor. Tukey's multiple comparison test was used to determine which means differed from the rest. Analysis of variance was performed using the GLM procedure of the SAS software package (SAS Institute, 2008).

III – Results and discussion

Chemical composition and *in vitro* fermentation kinetics of the browse foliage have been reported elsewhere (Boufennara *et al*., 2012), and the results presented herein are complementary to the informational ready published.

The CP content (Boufennara *et al*., 2012) of the plant species samples varied widely, being particularly high for *A. gombiformis* (223 g kg^{-1} DM) and low for the grasses *L. spartum* and *S. tenacissima* (73 and 75 g kg^{-1} DM, respectively). Protein content in dicotyledon species ranged wide-

ly from 109 to 223 g kg^{-1} DM and was always greater than in monocotyledon grasses. In general, monocots had higher NDF and ADF and lower lignin contents than dicots, whereas *A. halimus* and *A. gombiformis* showed low lignin contents.

Data of DM and NDF disappearances are shown in Table 1. *In situ* DM disappearance were variable (P<0.05) across the examined forages. The lowest *in situ* DM degradabilities were observed in monocotyledons (being particularly low for *S. tenacissima*), whereas dicots had significantly higher values. Similar trends have been observed for the *in vitro* fermentation kinetics estimated form the gas production (Boufennara *et al*., 2012). After 96 hours of incubation time, the highest *in sacco* DM disappearance was observed for *A. gombiformis* (0.85 g/g DM incubated) and the lowest was obtained by *S. tenacissima* (0.31 g/g DM). These results could be explained for *A. gombiformis* by the low levels of cell wall fraction NDF, ADL and also by their high concentrations of CP. The increase in the DM disappearance observed in the case of *A. gombiformis* and *A. halimus* may be due either to solubilization and dilution of phenolic compounds or simply to the loss of fine particles from the bags. In agreement with Lucci *et al*. (1989), the potential of degradation of the dry matter of the legumes was higher than that of the grasses, although after 96 h *L. spartum* showed a higher value than *C. saharae*. *In sacco* NDF disappearance was consistently ranked with the exception for *L. spartum*: dicots > monocotyledons (P<0.05). The highest value was recorded for *A. gombiformis* while *S. tenacissima* showed the lowest cell wall degradability (P<0.001). These results are consistent with their respective cell wall content (Boufennara *et al*., 2012).

Particle losses by washing the substrates studied are comparable with those recorded by Ghorbani and Hadj-Hussaini (2000). However these results are high compared with those noted by Arhab *et al.* (2006). These differences may be due either to the nature of the substrate, or the pore size of the bags and/or to the sample/contact area ratio (Michalet-Doreau and Nozière, 1999) or to the technique of washing used (De Boer *et al.*, 1987).

Table 1. *In situ* DM and NDF disappearances (g/g DM) of Algerian forages

Family	Substrate	DM			NDF		
		0 h	24 h	96 h	0 h	24 h	96 h
Dicotyledons							
Chenopodiaceae	*A. halimus*	0.414^{b}	0.739^{a}	0.810^{b}	0.206^{b}	0.496^{a}	0.604^{b}
Asteraceae	*A. herba-alba*	0.335^{c}	0.503^{c}	0.634^{c}	0.253^{ab}	0.409^{c}	0.487^{c}
Fabaceae – Leguminosae	*A. gombiformis*	0.498^{a}	0.676^{b}	0.849^{a}	0.189^{c}	0.501^{a}	0.645^{a}
	C. saharae	0.263^{d}	0.490^{cd}	0.538^{d}	0.173^{cd}	0.193^{d}	0.262^{d}
Monocotyledons							
Poaceae – Gramineae	*L. spartum*	0.261^{d}	0.486^{cd}	0.611^{c}	0.272^{a}	0.443^{b}	0.598^{b}
	S. tenacissima	0.114^{e}	0.196^{e}	0.314^{e}	0.122^{e}	0.155^{e}	0.225^{e}
R.S.D.†		0.012	0.017	0.018	0.067	0.013	0.016

† Residual standard deviation.

$^{a, b, c, d, e}$ Different superscripts in the same column indicate significant differences (P<0.05).

According to Mertens (1993), the factors of a physical nature such as crystallinity and degree of polymerization of the polysaccharides of the cell walls can have a significant effect on the kinetics of degradation, as well as lignin content. The specific examination of the kinetic data of the studied substrates reveals that the *in situ* NDF fraction degradation occurs mainly between 24 and 96 hours. Differences are also observed between species of the same family. These differences are principally attributed to the high lignin content and total nitrogen content, as well as the high losses of particles that may contain NDF fraction not recovered in the residue. The fraction

of crude protein and phenolics compounds does not seem to play a significant effect on the process of *in situ* degradation of the cell wall. These results are consistent with the works of many authors (Apori *et al.*, 1998). The potential role of phenolic compound on ruminal fermentation is poorly detected by *in sacco* method (Apori *et al.*, 1998). Indeed, the effect of the anti-nutritive factors, which are unlikely to be detected using *in sacco* method, could account for the differences between the two methods. In the *in vitro* gas production technique, which is a batch system with limited supply of rumen fluid, these anti-nutritive factors remain in the fermentation medium and affect rumen microbial activity. Conversely, in the *in sacco* technique, which is an open system with real rumen environment with a continuous microbial activity and growth, the inhibition would be transient. Khazaal *et al.* (1994) reported that the technique of *in vitro* gas production is more sensitive than *in sacco* technique for determining the nutritive value of forages containing tannins.

IV – Conclusions

Combined use of chemical analysis, an *in vitro* gas production and an *in situ* incubation technique is advocated to determine the nutritive value of feeds containing phenolic compounds. On the basis of these techniques, *A. gombiformis*, *A. halimus* and *A. herba-alba* have better nutritive potential for sheep grazing hill areas of Boussâda district in north Algerian desert than *L. spartum*, *C. saharae* and *S. tenacissima*.

References

Arhab R., Macheboeuf D., Doreau M. and Bousseboua H., 2006. Nutritive value of date palm leaves and *aristida pungens* estimated by chemical, *in vitro* and *in situ* methods. In: *Tropical and subtropical Agroecosystems*, 6(3), p. 167-175.

Apori S.O., Castro F.B., Shand W.J. and Orskov E.R., 1998. Chemical composition, *in sacco* degradation and *in vitro* gas production of some Ghanaian browse plants. In: *Animal Feed Science and Technology*, 76, p. 129-137.

Boufennara S., López S., Bousseboua H., Bodas R. and Bouazza L., 2012. Chemical composition and digestibility of some browse plants species collected from Algerian arid rangelands. In. *Spanish Journal of Agricultural Research*, 10 (1), p. 88-98.

De Boer G., Murphy J.J. and Kennelly J.J., 1987. A modified method for determination of *in situ* rumen degradation of feedstuffs. In: *Canadian Journal Anim*al *Sci*ence, 63, p. 93-102.

Ghorbani G.R. and Hadj-Hussaini A., 2000. *In situ* degradability of Iranian Barley grain cultivars. In: *Small Ruminant Research*, 44, p. 207-212.

Jalilvand G, Neserian A, Kebreab E, López, S and France J., 2008. Rumen degradation of alfalfa, maize silage and wheat straw treated with fibrolytic enzyms. In: *Archives de Zootechnie,* 57 (218), p.155-164.

Khazaal, K., Boza, J. and Ørskov, E.R., 1994. Assessment of phenolics-related anti-nutritive effects in Mediterranean browse: a comparison between the use of the *in vitro* gas production technique with or without insoluble polyvinyl polypyrrolidone or nylon bag. In: *Animal Feed Science and Technology*, 49, p. 133-149.

López S., France J., Dhanoa M.S., Mould F. and Dijkstra J., 1999. Comparison of mathematical models to describe disappearance curves obtained using the polyester bag technique for incubating feeds in the rumen. In: *Journal of Animal Science* 77, p. 1875-1888.

Lucci C.S., Noguira Filho J.C.M. and Melotti L., 1989. Digestibility and ruminal protein degradability of alfalfa and Rhodes grass hay. In: *Journal of Animal Science,* 67 (suppl.1), p. 498-505.

Makkar H.P.S., 2003. *Quantification of Tannins in Tree and Shrub Foliage*. A Laboratory Manual. Kluwer Academic Publishers, Dordrecht, the Netherlands.

Martens G.C., Buxton D.R. and Barnes R.F., 1993. Feeding value (forage quality). In: *Alfalfa and Alfalfa Improvement*. Hanson A.A, Barnes R.F., Jill R.R. (Eds.), Madison, Wisconsin, USA. p. 463-492.

Michalet-Doreau B. and Nozière P., 1999. Intérêts et limites de l'utilisation de la technique des sachets pour l'étude de la digestion ruminale. In: *INRA Production animale*,12, p. 195-206.

Preston T.R., 1995. Tropical animal feeding. A manual for research workers. *FAO Animal Production and Health*. Paper 126, Pub. FAO, Rome, Italy, p. 124.

SAS Institute, 2008. SAS/STAT® 9.2 User's Guide. SAS Institute Inc., Cary, NC, USA.

Steel R.G.D. and Torrie J.H., 1980. *Principles and Procedures of Statistics.* McGraw-Hill, New York, USA.