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Nutritive characterisation of shrubs browsed by goats during summer in the north-west of Tunisia

A. Boubaker*, C. Kayouli* and A. Buldgen**
*INAT, 43 avenue Charles Nicolle 1082 Tunis, Tunisia
**Faculté des Sciences Agronomiques de Gembloux, Passage des Déportés 2, 5030 Gembloux, Belgium

SUMMARY – In the north-west of Tunisia, goats are mainly maintained on natural vegetation throughout the year without any additional feed supply. Therefore, it is important to know the nutritive value of diet selected by animals particularly during the dry season. *In vitro* fermentation of six shrubs (*Erica arborea*, *Phyllerea angustifolia*, *Pistacia lentiscus*, *Myrtus communis*, *Quercus suber* and *Vibernum tinus*) mostly browsed in summer was investigated using a closed fermenter and compared with common hay. Moreover, the effect of PEG 4000 or feed block addition on *in vitro* fermentation of selected diet was studied. Diet was simulated on the basis of direct observation method results. Four goats receiving 500 g hay and 250 g concentrate twice a day were used as donors of rumen content. The browsed species were relatively low in crude protein [59-91 g/kg dry matter (DM)] and high in fibre (ADF: 266-407 g/kg DM). Values of pH and NH_3 revealed satisfactory fermentation conditions. There were differences in volume of gas produced after 72 h. *V. tinus* produced the highest volume (945 ml/13 g DM). The lowest production of gas was obtained with *Q. suber* (343 ml/13 g DM). However, all the shrub species showed less fermentation activity than hay. Polyethylene glycol (PEG) addition to the simulated diet led to a significant increase of gas production ($P < 0.001$). The effect of feed blocks supply was low compared with PEG addition.

Key words: Shrubs, gas production, goats, PEG, feed blocks.

RESUME *– "Caractérisation nutritionnelle des arbustes consommés par les caprins en été dans le Nord-Ouest de la Tunisie". Dans le Nord-Ouest de la Tunisie, les caprins sont conduits sur la végétation naturelle tout au long de l'année sans aucune complémentation. La connaissance de la valeur nutritive de la végétation consommée par les animaux, particulièrement durant la saison sèche est donc indispensable. Les échantillons des feuilles et brindilles de six arbustes ont été incubés* in vitro *dans un système de fermentation du type Batch. Les espèces sont :* Phylleria angustifolia*,* Erica arborea*,* Myrtus communis*,* Pistacia lentiscus*,* Quercus suber *et* Vibernum tinus*. Les arbustes étudiés se caractérisent par des teneurs faibles en matières azotées totales (5,9 à 9,1% de la matière sèche, MS) mais élevées en fibres (ADF : 26,6 à 40,7% de la MS). Les valeurs du pH et les concentrations en azote ammoniacal dans les fermenteurs révèlent des conditions favorables à l'activité microbienne. Le volume total de gaz produit suite à la fermentation de 13 g de MS a varié de 343 ml avec* Q. suber *à 945 ml avec* V. tinus*. Cependant, la production la plus importante a été notée avec le foin de vesce avoine (1178 ml). La ration simulée a produit plus de gaz en présence du PEG 4000 qu'en présence des blocs alimentaires.*

Mots-clés : *Arbustes, production de gaz, caprins, PEG, blocs alimentaires.*

Introduction

In the north-west of Tunisia, goats are mainly raised on natural vegetation throughout the year. The dry season normally lasts for 6-7 months (from June to December) and leads to a rapid decline in the qualitative value of natural vegetation. Animals reared in these regions may have problems to overcome maintenance requirements on natural vegetation without any additional feed supply resulting in low performance. The aim of this study was to evaluate the nutritive value of plants mostly selected during dry season. The effect of polyethylene glycol (PEG) or feed blocks addition on fermentation of diet selected by goats in summer was investigated.

Materials and methods

Plants

The samples were leaves and twigs of shrubs mostly browsed by goats in summer. The six

browse plants used included: *Erica arborea*, *Phyllerea angustifolia*, *Pistacia lentiscus*, *Myrtus communis*, *Quercus suber* and *Vibernum tinus*. The samples were harvested by hand and oven-dried at 40°C to minimize changes in tannins content and activity (Hagerman, 1988; Makkar and Singh, 1991). The studied plants were chosen based on a previous work (Kayouli and Buldgen, 2001), which indicated that in summer goat's diets consisted of *E. arborea* (10%), *M. communis* (10%), *V. tinus* (10%), *Q. suber* (20%), *P. lentiscus* (25%) and *Ph. angustifolia* (25%). Vetch oat hay was used as a reference for tannin free forage.

In vitro incubation

Four goats with permanent rumen cannulas maintained on a standard diet (70% hay and 30% concentrate) were used to provide the inoculum. The gas production was obtained through *in vitro* incubation of samples during 72 hours at 39°C, using the methodologies described by Jouany and Thivend (1986). The equivalent of 13 g dry matter (DM) of each sample was incubated in a flask with 100 g of solid rumen contents, 100 ml of filtrated rumen juice, 300 ml of artificial saliva and 5 ml of ammonium sulphate. Each sample was incubated in duplicate in three separate runs performed on different days. In each series, a blank rumen fluid without samples was run in duplicate. Sample of simulated diet was incubated alone, with 10% of PEG or 10% of feed blocks. Blocks were made, on the basis of crude weight, with 2% complement mineral vitamin, 5% phosphorus, 10% salt, 10% urea, 10% molasses, 10% wheat flour, 15% quicklime and 38% wheat bran. Gas production from samples was calculated by subtracting the volume of gas produced in the blanks. pH was determined on the medium at the end of incubation.

Laboratory analyses

Chemical analysis of the browsing fraction was carried out following AOAC (1975) procedures for determination of DM and organic matter (OM). Nitrogen concentration was determined by a macro-kjeldahl procedure and crude protein (CP) was calculated by multiplying N by 6.25. Acid detergent fibre (ADF) was determined by the procedure of van Soest *et al*. (1991). The total soluble phenolic compounds (TSPC) and the esterified phenolic compounds (EPC) were analysed on the same samples following the Scehovic (1990) methods.

Statistical analysis

The significance of difference between means was compared using Duncan's multiple range test after ANOVA for one way classified data with SAS/STAT program (SAS, 1985).

Results and discussion

Chemical composition

The chemical composition of different species browsed by goats in summer is presented in Table 1. The CP content is low in all species. Values ranged from 5.9% in *Ph. angustifolia* to 9.1% in *Q. suber*. The wide variation in fibre content (ADF) was comparable with that found in others studies on browse species (Reed, 1986; Makkar and Singh, 1991; Khazaal and Ørskov, 1994). Most of the woody species showed high concentration in soluble phenolic compounds. *P. lentiscus* and *M. communis* were the highest in TSPC while *V. tinus* and *Ph. angustifolia* exhibited lowest levels. Similar results were found with Mediterranean shrub-land browsed by goats in summer (Decandia *et al*., 2000).

In vitro fermentation

The data concerning the *in vitro* gas production from leaves and twigs of browses consumed by goats in summer are shown in Table 2. The fermentation of all studied species had stopped at 72 h,

which can be related to the low pH value and/or complete degradation of substrate. In all fermenters, the final pH was below 6.0. It is well known that, if pH is below 6.0, some bacterial enzymes and growth are inhibited (Russel *et al*., 1979) and the amount of gas produced decreases (Slyter *et al.*, 1964). The highest (945 ml/13 g DM) gas production was from *V. tinus* while the lowest (343 ml) was from *Q. suber*. However, all studied shrubs produced less gas than vetch oat hay (1178 ml). Addition of 10% of PEG to the medium containing simulated diet increased the gas production up to 46%, while a slight increase (up to 14%) was noted in presence of feed blocks.

Table 1. Organic matter (OM), crude protein (CP), acid detergent fibre (ADF), total soluble phenolic compounds (TSPC) and esterified phenolic compounds (EPC) contents of shrubs harvested in summer (% DM)

Species	OM	CP	ADF	TSPC	EPC
E. arborea	96.8	6.4	40.7	12.7	0.62
Ph. angustifolia	95.9	5.9	32.9	5.6	0.49
P. lentiscus	95.7	7.1	26.6	17.3	0.72
M. communis	95.8	7.0	28.7	17.5	0.69
Q. suber	96.2	9.1	39.9	10.3	0.89
V. tinus	93.6	6.3	31.1	7.8	0.40

Table 2. Values of pH and gas production (ml/13 g DM) at 72 h

	pH	Gas
E. arborea	5.5	655[e]
Ph. angustifolia	5.7	876[c]
P. lentiscus	5.5	601[e]
M. communis	5.6	657[e]
Q. suber	6.1	343[f]
V. tinus	5.4	945[b]
Vetch oat hay	5.5	1178[a]
Control diet	5.6	640[e]
Diet + 10% blocks	5.7	730[d]
Diet + 10% PEG	5.6	936[b]

[a,b,c,d,e,f]Values in the same column with different superscripts differ significantly ($P < 0.05$).

Various studies of the nutritive value of different browse species, including digestibility efficiency, determined by *in vitro* analyses underestimate the digestibility of these feeds (Nastis and Malechek, 1988; Nastis and Meuret, 1989) and may be related to the presence of secondary compounds such as tannins. High concentration of tannins affects enzyme activities of rumen bacteria (Makkar *et al*., 1989) and causes a negative bias in the *in vitro* estimates (Sidahmed *et al.*, 1981; Robbins *et al.*, 1987).

Experiments in which PEG was used to neutralize tannins have clearly shown that the major anti-nutritional effect of tannins is the depression of enzyme activities and reduction of cell wall digestibility. In numerous studies (Khazaal and Ørskov, 1994; Makkar *et al.*, 1995), various browse samples were incubated *in vitro* with and without tannins binding agents. The increase in gas production or degradability due to tannins-binding agent was used as an index for the effect of tannins on rumen degradation. This method was found efficient in ranking the negative effects of tannins.

Conclusions

The gas production measurement gives an indication of anti-microbial activity. However, the

measurement of gas alone in *in vitro* systems could lead to misleading conclusions on potential rumen modulators on the extent of digestion of tanniniferous feeds. It is therefore suggested, for tannin-rich feeds, that practical experiments should be carried out with target ruminant species.

References

AOAC, Association of Official Analytical Chemists (1975). *Official Methods of Analysis*, 12th edn. AOAC, Washington DC, USA.

Decandia, M., Sitzia, M., Cabiddu, A., Kababya, D. and Molle, G. (2000). The use of polyethylene glycol to reduce the anti-nutritional effects of tannins in goats fed woody species. *Small Rum. Res.*, 38: 157-164.

Hagerman, A.E. (1988). Extraction of tannins from fresh and preserved leaves. *J. Chem. Ecol*., 40: 453-461.

Jouany, J.P. and Thivend, P. (1986). *In vitro* effects of avoparcin on protein degradability and rumen fermentation. *Anim. Feed Sci. Tech*., 15: 215-229.

Kayouli, C. and Buldgen, A. (2001). *Elevage Durable dans les Petites Exploitations du Nord-Ouest de la Tunisie*. Faculté Universitaire des Sciences Agronomiques de Gembloux, Belgium.

Khazaal, K. and Ørskov, E.R. (1994). The *in vitro* gas production technique: An investigation on its potential use with insoluble polyvinylpolypyrrolidone for the assessment of phenolic-related antinutritive factors in browse species. *Anim. Feed Sci. Tech*., 47: 305-320.

Makkar, H.P.S., Blummel, M. and Becker, K. (1995). Formation of complexes between polyvinylpyrrolidones or polyethylene glycols and tannins, and their implication in gas production and true digestibility in *in vitro* techniques. *Br. J. Nutr.*, 73: 897-913.

Makkar, H.P.S. and Singh, B. (1991). Distribution of condensed tannins (proanthocyanidins) in various fibre fractions in young and mature leaves of some oaks species. *Anim. Feed Sci. Tech*., 32: 253-260.

Makkar, H.P.S., Singh, B. and Negi, S.S. (1989). Relationship of rumen degradability with microbial colonization, cell wall constituents and tannins levels in some tree leaves. *Anim. Prod.*, 49: 299-303.

Nastis, A. and Malechek, J.C. (1988). Estimating digestibility of oak browse diets for goats by *in vitro* techniques. *J. Range Manage*., 41: 255-258.

Nastis, A. and Meuret, M. (1989). Methods for estimating the nutritive value of range forage and intake by goats in the Mediterranean area. In: *L'Evaluation des Ovins et des Caprins Méditerranéens*, Flamant, J.C. and Morand-Fehr, E.P. (eds). EUR 11893. CCE, Luxembourg, Brussels, pp.142-158.

Reed, J.D. (1986). Relationship among soluble phenolics, insoluble proanthocyanidins and fibre in East browse species. *J. Range Manage*., 39(1): 5-7.

Robbins, C.T., Mole, S., Hagerman, A.E. and Hanley, T.A. (1987). Role of tannins in defending plants against ruminants: Reduction in dry matter digestion? *Ecology*, 68: 1606-1615.

Russel, J.B., Shamp, W.M. and Baldwin, R.L. (1979). The effect of pH on maximum bacterial growth rate and its possible role as a determinant of bacterial competition in the rumen. *J. Anim. Sci*., 48: 251.

SAS (1985). *SAS User's Guide: Statistics*, 5th edn. SAS Inst. Inc., Cary, NC, USA.

Scehovic, J. (1990). Tannins et autres polymères phénoliques dans les plantes de prairies: Détermination de leur teneur et de leur activité biologique. *Revue Suisse d'Agriculture*, 22: 179-184.

Sidahmed, A., Morris, J.G., Koong, L.J. and Radosevich, S.R. (1981). Contribution of mixtures of three chaparral shrubs to the protein and energy requirements of Spanish goats. *J. Anim. Sci*., 53: 1391-1400.

Slyter, L.L., Nelson, W.O. and Wolin, M.J. (1964). Modification of a device for maintenance of the rumen microbial population in continuous culture. *Appl. Microbiol.*, 12: 374.

van Soest, P.J., Robertson, J.B. and Lewis, B-A. (1991). Methods for dietary fibre, neutral detergent fibre, and non-starch carbohydrates in relation to animal nutrition. *J. Dairy Sci*., 74: 3583-3597.