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Nutrient and tannin content of browsing shrub legumes informally used for small ruminant feeding in Canary Islands, Spain

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Abstract. The objective of this study was to contribute to the characterization of nutritional potential, with special attention to the profiles on phenolic compounds and condensed tannins, of some native browsing shrub legumes informally used for ruminant feeding in Canary Islands. The species selected for this study were *Bituminaria bituminosa* var. *bituminosa, Bituminaria bituminosa* var. *albormaginata, Chamaecytisus proliferus* var. *palmensis, Chamaecytisus proliferus* var. *canariae and Adenocarpus foliosus.* Crude protein (CP) ranged from 10.6% (*Bituminaria b. bituminosa*) to 18.5% (*Adenocarpus foliosus*) whereas neutral detergent fibre (NDF) was between 39.9% (*Chamaecytisus p. canariae*) and 51.6% (*Bituminaria b. albormaginata*). Condensed tannins expressed as catechin equivalent ranged from 0.1% (*Bituminaria b. albormaginata*) to 0.5% (*Bituminaria b. bituminosa)*, and total phenols expressed as tannic acid equivalent ranged from 0.9% (*Bituminaria b. albormaginata*) to 3.5% (*Chamaecytisus p. palmensis*). The organic matter digestibility (OMD) ranged from 51.9% (*Bituminaria b.albormaginata*) to 71.5% (*Chamaecytisus p. canariae*). Current results support the thesis that, according to the more local empiric practices, native flora of Canary Islands have an under exploited potential with the capacity to assist eventual changes in ruminant feeding systems strategies. Nevertheless, deeper characterization and in vivo evaluation studies of the species covered in this study are required at different seasons and vegetative stages (e.g. digestibility *in vivo*, palatability, voluntary intake, productive response).

Keywords. Total phenols – Condensed tannins contents – Browsing shrub legumes – *Bituminaria bituminosa* sp. – *Chamaecytisus* sp. – *Adenocarpus foliosus* – Tedera – Tagasaste.

Le potentiel nutritionnel et la composition en composés phénoliques et en tannins condensés, de arbustes fourragers locaux utilisés dans l'alimentation des ruminants dans les îles Canaries

Résumé. *L'objectif de cette étude était de contribuer à caractériser le potentiel nutritionnel et en particulier la composition en composés phénoliques et en tannins condensés, de certain arbustes fourragers locaux utilisés dans l'alimentation des ruminants dans les îles Canaries. Les espèces étudiées étaient :* Bituminaria bituminosa *var.* bituminosa*,* Bituminaria bituminosa *var.* albormaginata*,* Chamaecytisus proliferus *var.* palmensis*,* Chamaecytisus proliferus *var.* canariae *and* Adenocarpus foliosus*. Les teneurs en matières azotées totales (CP) s'étendaient de 10,6% (*Bituminaria b. *var.* bituminosa*) à 18,5% (*Adenocarpus foliosus*) et celle en neutral detergent fibre (NDF) de 39,9% (*Chamaecytisus pr. *var.* canariae*) à 51,6% (*Bituminaria b. *var* albormaginata*). Les teneurs en tannins condensés exprimés en équivalent catechine variaient de 0,11% (*Bituminaria b. *var* albormaginata*) à 0,51% (*Bituminaria b. *var.* bituminosa*), et les phénols totaux exprimés en équivalent acide tannique, de 0,92% (*Bituminaria b. *var.* albormaginata*) à 3,57% (*Chamaecytisus pr. *var.* palmensis*). La OMD variait de 51,95% (*Bituminaria b. *var* albormaginata*) à 71,55% (*Chamaecytisus pr. *var.* canariae*). Nos résultats montrent que la flore native des îles Canaries utilisée de manière empirique par les éleveurs, est une source fourragère sous-exploitée qui pourrait être utilisée dans le cadre de nouvelles stratégies de systèmes d'alimentation. Cependant une caractérisation* in vivo *à différentes saisons et stades physiologiques (digestibilité, appétence, ingestibilité, niveau de production permis) est nécessaire.*

Mots-clés. *Phénols totaux – Tannins condensés – Arbustes légumineuses* – Bituminaria bituminosa *sp.* – Chamaecytisus *sp.* – Adenocarpus foliosus – *Tedera – Tagasaste.*

I – Introduction

Browsing legume plants have been largely reported to be used for small ruminant feeding (i.e. sheep and goats) as feed resources in tropics, subtropics, arid and dry regions, during dry seasons, mainly. They are known to be tolerant to drought having the ability to accumulate green fodder over several seasons, controlling erosion, providing fodder reserves for times of dearth and contributing, as legumes plants, for positive impacts on soil fertility with organisms which fix atmospheric nitrogen (Le Houérou, 2000). Nevertheless their use has been limited by scant research on their nutritional and chemical properties, in particular on anti nutritional factors. The presence of tannins in browsing legumes plants is normally associated with limiting factor to the utilization as feedstuffs (Mangan, 1988; Kumar and Vaithiyanathan, 1990). In Canary Islands there are some native and endemic shrub legumes, which grow spontaneously and traditionally, that have been used by local goat and sheep keepers as feed resources. However, there is still scarce literature about their particular characteristics which had lead to a poor promotion at local and regional level. The objective of this study was to assess the nutritive value of some of these legumes shrub, specially taking into account their profiles on phenolic compounds and condensed tannins for select properly the species and the variety of the legumes shrubs for animal nutrition.

II – Materials and methods

1. Experimental material, site and chemical analysis

The species used in this study were *Bituminaria bituminosa* var. *bituminosa (B. b. bituminosa), Bituminaria bituminosa* var. *albormaginata (B. b. albormaginata), Chamaecytisus proliferus* var. *palmensis (Ch. p. palmensis)*, *Chamaecytisus proliferus* var. *canariae (*Ch. p. *canariae)* and Adenocarpus *foliosus (A. foliosus*), all of them are shrub or "semi-shrub" legumes, native (endemic) from Canary Islands, specifically from different localities in Gran Canaria (latitude 27° 55' 45"; longitude 15° 23' 20"). The original plants were randomly selected from spontaneous populations which have been developed without irrigation or fertilization during May 2009. Thin stems (less than 3 mm diameter) of mature shrubs with their leaves, steams and flowers were collected. Ash (ASH), organic matter (OM) and crude protein (CP) were determined in duplicated samples according to standard methods as described in AOAC (2000). Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined following the procedure of Van Soest *et al.* (1991). Condensed tannin analysis and total phenolic content were performed by the vanillin-HCL method of Burns (1963) and the technique of Makkar *et al*. (1993) respectively; *in vitro* dry matter digestibility (DMD) and organic matter digestibility (OMD) was determined according to the two stage pepsin-cellulase method (Pepcel) (Aufrere, 1982). To assess the content of nutrients according to the type of plant, an analysis model of variance with a factor of variation (ANOVA-1) was used (SAS, 2000).

III – Results and discussion

The chemical composition, OMD, DMD are seen in Table 1, CP, ranged from 10.6% (*B. b. bituminosa*) to 18.5% (*A. foliosus*) and were significantly different in all the species, a exception of *Ch. p. palmensis* and *Ch. p. canariae*, which have similar CP content. NDF ranged between 39.9% (*Ch. p. canariae*) to 51.6% (*B. b. albormaginata*), from which NDF of *Ch. p. canariae* and *A. foliosus* were both, significantly similar and also NDF, were similar in *B. b. albormaginata* among *B. b. bituminosa*. The ASH ranged between 3.9% (*Ch. p. canariae)* to 6.9% *(B. b. albormaginata)*, there are a significantly similar ASH content between *Ch. p. palmensis* and *Ch. p. canariae* and between *A. foliosus* and *B. b. bituminosa* too. OMD (Table 1) ranged between 51.9% *(B. b. albormaginata*) to 71.5% (*Ch. p. canariae*), all the values were significantly different from each other. Although OMD and DMD of *Chamaecytisus proliferus* sp. were higher than from *Bituminaria b.* sp. and *A. foliosus.*

Table 1. Chemical composition (% DM), total phenols (% of tannins as tannic acid equivalent), condensed tannins content (%of tannins as catechin equivalent), organic matter digestibility (% OMD) and dry matter digestibility (% DMD)

Species	DM	OM	CP	NDF	ADF	ADL	Ash	CT	Total phenols	DMD	OMD
Bituminaria bituminosa											
var. *albormaginata*	63.5	88.7	11.9 ^{a}	51.6 ^{a}	37.4 ^{a}	9.7 ^{a}	6.9 ^{a}	0.1 ^{a}	0.9 ^{a}	55.4 ^{a}	51.9 ^{a}
var. *bituminosa*	40.7	87.7	10.6 ^{c}	49.0 ^{a}	33.5 ^{a}	7.6 ^{b}	5.2 ^{b}	0.5 ^{c}	1.4 ^{b}	61.6 ^{c}	59.4 ^{c}
Chamaecitysus proliferus											
var. *palmensis*	41.5	89.8	16.0 ^{b}	45.2 ^{c}	25.5 ^{a}	8.8 ^{c}	4.1 ^{c}	0.3 ^{b}	3.5 ^{c}	67.9 ^{b}	66.4 ^{b}
var. *canariae*	49.7	90.2	15.7 ^{b}	39.9 ^{b}	29.9 ^{a}	11.8 ^{d}	3.9 ^{c}	0.3 ^{b}	2.8 ^{d}	72.5 ^{d}	71.5 ^{d}
Adenocarpus foliosus	43.5	89.1	18.5 ^{d}	40.3 ^{b}	24.6 ^{a}	7.9 ^{b}	5.2 ^{b}	0.4 ^{b}	2.0 ^{e}	64.7 ^{e}	63.4 ^{e}
P			<.001	<.001	.031	.002	<.001	<.001	<.001	<.001	<.001

DM: dry matter; OM: organic matter; CP: crude protein; NDF: neutral detergent fibre; ADF: acid detergent fibre; ADL: acid detergent lignin; CT: condensed tannins; DMD: dry matter digestibility; OMD: organic matter digestibility.

The results of total phenols and condensed tannins are in Table 1; condensed tannins ranged between 0.1% (*B. b. albormaginata*) to 0.5% (*B. b. bituminosa*) and showed a significantly similar content between *Ch. p. palmensis, Ch. p. canariae* and *A. foliosus*. Total phenols ranged from 0.9% (*B. b. albormaginata*) to 3.5% tannic acid equivalent on (*Ch. p. palmensis*) and there were significantly different between all of them. In Fig. 1 we can see the correlations between chemical compositions and OMD of the different species, exist a negative correlation between mean value of ASH, FND, FAD among OMD while there is a positive correlations between total phenols and OMD. Probably this fact is explained but the ability of the tannins to combine with dietary proteins, minerals and polymers such as cellulose, hemicellulose, pectin and minerals thus retarding their digestion (McSweeney *et al.*, 2001). Thus tannins can reduce nitrogen availability to rumen microorganisms and they may be advantageous by protecting dietary protein from digestion in the rumen and thus increasing total supply of protein for absorption (D'Mello, 1992).

	OMD	T_Phenol	Tannin
ASH	-.580*	-.842**	-.467
CP	.434	.477	-.018
NDF	-.82**	-.330	.035
ADF	-.594*	-.565	-.302
ADL	-.336	.102	-.316
OMD		.621*	-.126
T-Phenol			.342

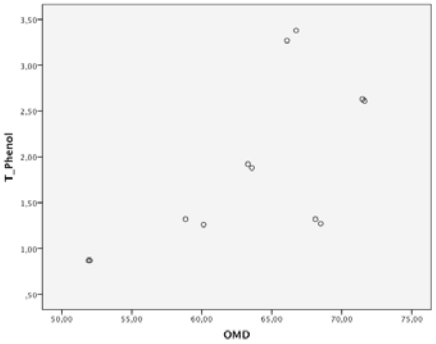

Fig. 1. Matrix and correlations of Spearmean between chemical compositions. *P < 0.05; **P < 0.01.

IV – Conclusions

The value of forages as supplements is mainly depending on their capacity to provide essential nutrients to the rumen microbial population and/or critical nutrients (anti-nutritive factors) to meet the host animal requirements, thus increasing or reducing the efficiency of feed utilization

(Elliot and McMeniman, 1987). In this study we can see that there is a positive correlation between total phenols and OMD of the canary shrubs, but also there are many differences of total phenols within the shrubs species and their variety. Although the fact that the tannins content present in tropical shrubs is now a days associated with beneficial properties in the context of ruminant nutrition (Barry *et al*., 1986; Mangan, 1988) due to the prevention of bloat in cattle and sheep, protecting the leaf protein from the rumen digestion and increasing the supply of high quality protein for absorption; more research should be done on the relation between the quantity of total phenols and tannins and the possible toxic effects on animals, the reduction on voluntary dry matter intake, palatability and productive response. For this reason, the quantification of tannins is important to properly select the species and the variety of the legume shrubs for animal nutrition according to their effect on browsing animals.

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