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Evaluation of lambs propensity towards different accessions of *Psoralea*

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Abstract. Animal propensity towards a food is mainly based on pre-ingestive stimuli, and could be measured by the intake rate. A short-term test, using the micro-swards method, was carried out to measure lambs propensity for different accessions of *Psoralea* genus, a perennial legume widely distributed in Mediterranean regions. The following 4 accessions of *Psoralea* were evaluated: *Psoralea bituminosa crassiuscula* Vilaflor; *Psoralea bituminosa bituminosa* Llano del Beal; *Psoralea bituminosa bituminosa* Monte Rosello; *Psoralea morisiana* Punta Giglio. The forages were offered, in a 4x4 latin-square design with 3 replicates, to 12 Sarda lambs, first adapted to the test routine with *Hordeum vulgare* L.. Fresh matter intake (FMI) and DM intake (DMI, g head⁻¹), number of bites (NB, n.), eating time (ET, min), bite frequency (BF, n. min⁻¹) and intake rate (IR, g min⁻¹) were measured in 5 min sessions. Overall, lambs showed a low propensity for all accessions of *Psoralea* with a slightly higher DM IR for Vilaflor ($P \leq 0.05$).

Keywords. Feeding behaviour – Intake rate – Sheep – *Psoralea*.

Évaluation de la propension des agneaux vers différentes accessions de *Psoralea*

Résumé. La propension des animaux vers un aliment est principalement basée sur la stimulation pré-ingestive, et pouvait être mesurée par le taux d'ingestion. Un essai à court terme, en utilisant la méthode de micro-swards, a été réalisé pour mesurer la propension des agneaux pour différentes accessions du genre *Psoralea*, une légumineuse pérenne largement distribuée dans les régions méditerranéennes. Les 4 suivantes accessions de *Psoralea* ont été évalués: *Psoralea bituminosa crassiuscula* Vilaflor; *Psoralea bituminosa bituminosa* Llano del Beal; *Psoralea bituminosa bituminosa* Monte Rosello; *Psoralea morisiana* Punta Giglio. Les fourrages ont été offerts, dans un 4x4 carré latin avec 3 répétitions, à 12 agneaux de race Sarde, d'abord adaptée à la routine de test avec *Hordeum vulgare* L.. L'ingestion de matière fraîche (FMI) and sèche (DMI, g tête⁻¹), le nombre de préhensions (NB, n.), le temps d'ingestion (ET, min), la fréquence de préhensions (BF, n. min⁻¹) et le taux d'ingestion (IR, g min⁻¹) ont été mesurés pendant 5 min d'observation. Dans l'ensemble, les agneaux ont montré une faible propension pour toutes les accessions de *Psoralea*, avec une faible préférence pour Vilaflor qu'a montré un plus haut DM IR ($P \leq 0.05$).

Mots-clés. Comportement alimentaire – Taux d'ingestion – Brebis – *Psoralea*.

I – Introduction

Psoralea bituminosa C.H. Stirton (syn. *Bituminaria bituminosa* L.) is a perennial legume widely distributed in the Mediterranean Basin, and it grows and remains green all-year-round even during summer and autumn. *Psoralea* genus has a large diversity with 3 varieties of *P. bituminosa* found in the Canary Islands (*albomarginata*, *crassiuscula*, and *bituminosa*) and an endemic species (*P. morisiana*) present in Sardinia (Porqueddu *et al.*, 2011). *P. bituminosa* is usually considered of low palatability because of the strong smell that can be emitted by oil glands located on its foliage. However the nutritive value of *P. bituminosa* in terms of forage composition and digestibility was proven similar to or even better than that of other legumes. However, the aerial part of this species may contain a high concentration of furanocoumarins, out of which psoralen and angelicin are the most abundant (Pecetti *et al.*, 2007). These substances could be harmful

to animals, being responsible for contact photodermatitis, in addition to possibly limiting forage intake. Nevertheless *P. bituminosa* is traditionally used for feeding goats in the Canary Islands (Ventura *et al.*, 2009), and is assumed to be tolerant to heavy grazing with cattle (Sternberg *et al.*, 2006). The potentiality of *Psoralea* as forage species for dairy sheep is less known. For that reason an experimental test was carried out to evaluate the propensity of Sarda lambs towards different accessions of *Psoralea*.

II – Materials and methods

A short-term test was carried out to measure lambs propensity for 4 accessions of *Psoralea*. These were: *P. bituminosa crassiuscula* Vilaflor; *P. bituminosa bituminosa* Llano del Beal; *P. bituminosa bituminosa* Monte Rosello; *P. morisiana* Punta Giglio. The forages were sown separately in thirty replicate plastic boxes (46.5 cm, 28.5 cm, 14 cm) per accession (120 boxes in total) to establish micro-swards (Orr *et al.*, 2005). The seeds were sown on average at a rate of 20 g m⁻². The boxes were hand-watered when the soil surface was deemed dry. Each accessions was offered in a 4 x 4 Latin-Square design with 3 replicates to a total of twelve Sarda lambs, aged 126 ± 2 days (mean ± SE), with a live weight of 23.4 ± 0.8 kg. No lamb had previous experience of grazing *Psoralea*. In a pre-experimental period of 10 days the lambs were adapted to individual boxes with concrete floor and fed with ryegrass hay and a commercial concentrate. Since then they were familiarized to the propensity test routine using micro-swards sown with *Hordeum vulgare* L. (training period, 4 days). After this they were submitted to the experimental treatments (experimental period, 4 days). During this period, between 10 and 12 a.m., the lambs were daily exposed in a random sequence to one of the treatments (two paired boxes of one accession) for about 5 min. During the test the behaviour of the lambs was video-recorded. The micro-sward boxes were weighed before and after each test in order to determine the biomass removed, corrected for evapotranspiration losses (ET), measured using micro-swards of the same accession. Every day the sward surface height (SSH) of each micro-sward was measured by a sward stick before and after grazing. On 2 occasions during the experiment one micro-sward per accession not offered to the animals, was cut at the root-shoot interface after SSH measurement. The samples were freeze-dried and submitted for DM, CP, EE, NDF, ADF, ADL (AOAC, 1990), N fractions (Licitra *et al.*, 1996), water soluble carbohydrates (WSC, Martillotti *et al.*, 1987) determinations. Non fiber carbohydrates (NFC) were then calculated. Total (Tot. Ph.) and tannic phenols (Tan. Ph.), using Folin Ciocalteu's reagent, and condensed tannins (CT), using the butanol-HCl method and expressing the concentration as leucocyanidin, were also determined. On the basis of weight and chemical measurements and video analysis, the following behavioural parameters were calculated with reference to each 5 min propensity test: intake on fresh (FMI) and on dry matter (DMI) basis (g head⁻¹); eating time (ET, min); number of bites (NB, n.); bite mass (BM, g); bite frequency (BF, n min⁻¹) and intake rate (IR, g min⁻¹). Acceptability index was also calculated for each accession as proportion of lambs with minimum intake on total lambs exposed (%). Chemical parameters were analysed with GLM procedure using forage treatment as fixed effect. SSH and behavioural parameters were analysed with mixed procedure, using forage treatment as fixed effect and animal, day and replicate as random effects. Treatment means were separated by Tukey test (P<0.05). Chi-Square analysis was performed on acceptability index. Regression analyses were also performed to explore relationships between behavioural data and chemical parameters using daily accession values averaged across replicates (SAS, 2001).

III – Results and discussion

The chemical composition of the different accessions is reported in Table 1. *Llano del Beal* showed the highest level of CP followed by *Monte Rosello*, *Vilaflor* and *Punta Giglio* (P<0.05). On the contrary *Punta Giglio* presented the highest level of EE (P<0.03) and higher NFC than all the

other accessions ($P < 0.02$) with the exception of *Vilafior*. Fibre fractions were greater in *Monte Rosello* in particular ADF ($P < 0.01$) and ADL ($P < 0.03$). *Punta Giglio* showed lower level of fibre fractions as already observed by Porqueddu *et al.* (2011). No difference was found in N fractions (not shown) and in total phenols and tannic phenols (Table 1). No condensed tannin was detected in any accession.

Table 1. Chemical composition (% DM) of different accessions of *Psoralea* offered to lambs during the propension test (Lsmeans \pm SE)

	Llano del Beal	Monte Rosello	Punta Giglio	VilaFlor	P \leq
DM	14.1 \pm 1.0	13.3 \pm 1.0	17.3 \pm 1.0	18.5 \pm 1.0	0.06
OM	86.2 \pm 0.5 c	86.9 \pm 0.5 bc	89.2 \pm 0.5 a	88.6 \pm 0.5 ab	0.05
CP	18.8 \pm 0.9 a	17.1 \pm 0.9 ab	13.6 \pm 0.9 c	14.2 \pm 0.9 bc	0.05
EE	4.0 \pm 0.2 b	3.7 \pm 0.2 b	4.7 \pm 0.2 a	3.4 \pm 0.2 b	0.03
NFC	26.5 \pm 1.8 bc	20.5 \pm 1.8 c	34.1 \pm 1.8 a	31.6 \pm 1.8 ab	0.02
WSC	2.6 \pm 0.1	3.3 \pm 0.1	5.1 \pm 0.1	4.2 \pm 0.1	0.18
NDF	43.5 \pm 2.2	52.2 \pm 2.2	41.8 \pm 2.2	45.0 \pm 2.2	0.09
ADF	28.1 \pm 0.8 b	35.0 \pm 0.8 a	22.7 \pm 0.8 c	27.5 \pm 0.8 b	0.01
ADL	4.8 \pm 0.3 b	6.1 \pm 0.3 a	4.5 \pm 0.3 b	6.0 \pm 0.3 a	0.03
Tot. Ph.	1.8 \pm 0.1	1.6 \pm 0.1	2.1 \pm 0.1	1.6 \pm 0.1	0.29
Tan. Ph.	0.4 \pm 0.1	0.5 \pm 0.1	0.6 \pm 0.1	0.4 \pm 0.1	0.37

Values in the same row with different letters differ significantly ($P < 0.05$).

The highest pre- and post-grazing sward height was found in *Monte Rosello* (35.9 \pm 1.0 and 34.3 \pm 0.7 cm respectively) whereas the lowest in *Llano del Beal* (16.1 \pm 1.0 and 14.4 \pm 0.7), being *Vilafior* (26.7 \pm 1.0 and 25.1 \pm 0.7) and *Punta Giglio* (24.3 \pm 1.0 and 22.4 \pm 0.7) intermediates ($P < 0.001$). Overall feeding behaviour variables parameters measured (Table 2) showed very low values as compared to those found in similar experiments with adult dairy sheep (Giovanetti *et al.*, 2011). This could be expected, considering the role of learning in feeding behaviour expression (Villalba and Provenza, 2009).

Table 2. Behavioral parameters of lambs fed with different accessions of *Psoralea* (Lsmeans \pm SE)

	Llano del Beal	Monte Rosello	Punta Giglio	VilaFlor	P $<$
Eating time (min)	2.46 \pm 0.5	2.66 \pm 0.5	1.88 \pm 0.5	2.95 \pm 0.5	0.22
FM bite mass (g)	0.38 \pm 0.06	0.41 \pm 0.05	0.41 \pm 0.06	0.35 \pm 0.05	0.81
DM bite mass (g)	0.05 \pm 0.01	0.05 \pm 0.01	0.07 \pm 0.01	0.06 \pm 0.01	0.38
Bite rate (n. min ⁻¹)	14.6 \pm 3.2 ab	11.9 \pm 3.2 ab	9.5 \pm 3.2 b	16.6 \pm 3.2 a	0.05
FM intake rate (g min ⁻¹)	5.14 \pm 1.0	4.91 \pm 1.0	3.34 \pm 1.0	5.83 \pm 1.0	0.17
DM intake rate (g min ⁻¹)	0.69 \pm 0.1 ab	0.67 \pm 0.1 ab	0.57 \pm 0.1 b	1.08 \pm 0.1 a	0.03

Values in the same row with different letters differ significantly ($P < 0.05$).

The intake rate, often regarded as a gauge of forage immediate palatability showed higher level on DM basis in *P. bituminosa crassiuscula Vilafior* than *P. morisiana Punta Giglio* ($P < 0.03$). This fact was also confirmed by the acceptability index since comparing the accessions, *Vilafior* showed higher acceptability index than *Punta Giglio* ($P < 0.03$, Fig. 1). Using daily mean accession values, a negative relationship was detected between FMIR and total phenols (FMIR = + 13.0 \pm 3.9 - 4.66 \pm 2.2 Tot.Ph; $R^2 = 0.25$, $P < 0.05$, RMSE = 2.0, CV = 42.0) indicating a probable effect of these compounds in reducing palatability.

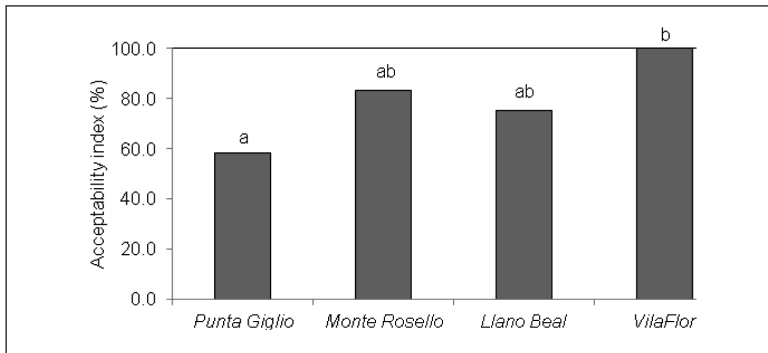


Fig. 1. Acceptability index of *Psoralea* accessions as proportion of lambs with a minimum intake (% of exposed lambs).

V – Conclusions

The results of the experiment indicate that the propension of naïve lambs towards the studied accessions of *Psoralea* is very low in particular for *P. morisiana*, probably because of its content of secondary compounds (e.g. furocoumarins). Further studies are warranted to evaluate ingestive response in adult sheep featured by greater foraging experience and higher feeding requirements than lambs.

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