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The role of grazed pasture in dairy Mediterranean sheep farming system

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Abstract. In Mediterranean environment the traditional dairy sheep farming system is based on pasture. The aim of this work was to compare a pasture grazing system with an indoor management in dairy sheep to better understand the role of grazed pasture as principal feed source. The trial was carried out in N-W Sardinia, between July 2011 and May 2013. In both years, for each season, a 4 week observation period was assessed. Two groups of 16 animals belonging to Sarda breed, were raised with two contrasting managements: Traditional management (TM) and Confined management (CM). The TM group was managed 24 h at pasture and it received a supplementation of hay and commercial concentrate, CM group was raised indoor, with any access to pasture, and fed with hay and commercial concentrate. Preliminary results indicate better performance (milk yield and body condition score) in TM than CM group. Overall, the herbage on offer ranged between 0.2 t DM/ha in winter to 1.7 t DM/ha in spring, covering between 15 and 70%of total animal energy requirements.

Keywords. Grassland – Hay – Sheep – Milk – Cortisol – Temperature humidity index.

Le rôle du pâturage dans les systèmes d'élevage méditerranéens de brebis laitières

Résumé. *En milieu méditerranéen le système traditionnel d'exploitation des brebis laitières est basé sur le pâturage. Le but de cette étude était de comparer un système traditionnel basé sur les prairies permanentes (TM) à un système dans lequel les brebis sont en stabulation toute l'année (CM), afin de mieux comprendre le rôle joué par les prairies. L'essai a été réalisé dans le NO de la Sardaigne, à 650 m d'altitude, entre Juillet 2011 et mai 2013. Deux groupes de 16 brebis de race Sarde ont été gérées dans chacun des deux systèmes. Les observations ont été réalisées durant 4 semaines par saison pendant deux ans. Le groupe TM a été géré 24 h au pâturage et il a reçu une complémentation de foin et de concentré, le groupe CM a été géré à l'intérieur et nourri avec du foin et du concentré. Les résultats préliminaires montrent une meilleure performance (production de lait et état corporel) dans le groupe TM que dans le groupe CM. Dans le système TM, la disponibilité d'herbe a varié entre 0,2 t MS/ha en hiver et 1,7 t MS/ha au printemps, couvrant entre 15 et 70% du total des besoins énergétiques de l'animal.*

Mots-clés. *Prairies – Foin – Brebis – Lait – Cortisol – Index de température et d'humidité.*

I – Introduction

In Mediterranean environment sheep are traditionally managed extensively and they have to face with an unbalance of quantity and quality of pasture with hypothetical detrimental effect on milk production. Meteorological variability can as well affect the thermal and physical comfort of the animals (Dwyer, 2009). However, grazing pasture can improve the production quality and animal welfare (Cabiddu *et al.*, 2005; Napolitano *et al.*, 2005). With the aim to understand the role of grazed pasture in the ewe performance a comparison between grazing management and indoor management was carried out during 2011 and 2013 in dairy sheep.

II – Materials and methods

The trial was carried out in N-W Sardinia, between July 2011 and May 2013, in the experimental farm of Agris Sardegna (lat 39°N, long 9 °E), at 670 m a.s.l. The climate is Mediterranean with hot, dry summers and mild and rainy winters (mean of maximum temperature of hottest month = 32.9°C; mean of minimum temperature of coldest month = 4.1°C; total annual rainfall = 1000 mm). In both years, for each season (A = autumn; W = winter; Sp = spring; Su = summer), a 4 week observation period was assessed. Two groups of 16 animals belonging to Sarda breed, were raised under two contrasting managements: Traditional management (TM) and Confined management (CM). The TM group was managed 24 h at pasture while CM group was raised indoor, with any access to pasture. Both groups received hay and commercial concentrate. The feed diets were calculated according to animal requirements of their physiological state (early lactation in W, late lactation in Sp; dry in Su and end of pregnancy in A) and, for TM, to herbage availability. The supplement consumption were measured daily in both groups. The pasture productivity and quality was evaluated during each observation period monitoring herbage on offer (HO, t DM ha^{-1}), by cutting 12 samples ha^{-1} (0,50 m^2) and sward height (SWH, cm; 150 records ha^{-1}). Fresh forage was dried at 65 °C, the samples were analysed using a Foss NIRSystems (Hoganas, Sweden). Body Condition Score (BCS), milk yield and milk composition were measured weekly. In the same occasion individual blood cortisol level was detected as stress marker. Because of the wide range of basal cortisol value, the variation of cortisol level was calculated as a difference between the last and the first blood sampling for each season (ΔCortisol). Outdoor and indoor meteorological factors were monitored continuously during the trial and were analyzed hourly to make a more accurate study. Temperature humidy index (THI) was calculated according to Peana *et al*. (2007) in which the last three discomfort classes were the same used for Livestock Weather Safety Index LWSI (Alert; Danger and Emergency; LCI, 1970). Permanence of THI was finally considered in different discomfort classes. Data farming were analyzed with the GLM procedure of SAS using the season (S), the management (M) and their interaction (SxM) as fixed effects. Differences between means of meteorological data within the same season were determined using Welch Two Sample t-test.

III – Results and discussion

The indoor condition has not mitigated cold temperatures in winter and has enhanced warm conditions in spring and summer (Table 1). Hay and concentrate offered were different between TM and CM and they covered on average 51% for TM and 136% for CM of the total energy ewe requirement per day (Table 2).

Table 1. Meteorological data recorded in TM and CM and their comparison within the same season (A = autumn; W = winter; Sp = spring; Su = summer; Lsmeans ± std. err)

	TM				CM			
	A	W	Sp	Su	A	W	Sp	Su
T_{max}	15 ± 2.4^a	12.2 ± 4.4^a	17.5 ± 3.6^a	28.3 ± 4.7^a	15.6 ± 2.4^a	13.1 ± 4.9^a	19.5 ± 4.1^b	30.8 ± 4.4^b
T_{min}	8.9 ± 2^a	4.4 ± 3.3^a	8.7 ± 2.6^a	15.8 ± 2.8^a	9.4 ± 2.1^a	5.3 ± 2.9^a	9.8 ± 2.3^b	17.1 ± 2.4^b
THIavg	52.8 ± 3.3^a	47.0 ± 6.3^a	54.9 ± 4.5^a	67.1 ± 3.9^a	53.9 ± 3.3^a	48 ± 6.2^a	56.9 ± 4.4^b	69.2 ± 3.3^b
THIAC	0	0	0	2.3 ± 3^a	0	0	0	3.5 ± 1.9^b

T_{max}, T_{min} = Maximun and minimum temperature (°C); THI_{AC} = THI in Alert class (h/d); a, b: different letters within same season differ for P<0.05.

Table 2. Daily concentrate (Con; kg/head/day), hay supplementation (kg/head/day) consumed, animal energy requirements (ER, UFL/day) and percentage of energy requirement covered by supplements (ES,%) in TM and CM groups (A = autumn; W = winter; Sp = spring; Su = summer; Lsmeans ± std. err)

	TM				CM				Effect of treatments		
	A	**W**	**Sp**	**Su**	**A**	**W**	**Sp**	**Su**	**S**	**M**	**SXM**
Con	0.43 ± 0.01^{a}	0.44 ± 0.01^{a}	0.33 ± 0.01^{c}	0.27 ± 0.01^{d}	0.43 ± 0.01^{a}	0.44 ± 0.01^{a}	0.42 ± 0.01^{ab}	0.40 ± 0.01^{b}	0.01	0.01	0.01
Hay	0.49 ± 0.04^{d}	0.29 ± 0.04^{e}	0.00 ± 0.04^{f}	0.27 ± 0.05^{e}	1.17 ± 0.04^{c}	1.59 ± 0.04^{a}	1.55 ± 0.04^{a}	1.30 ± 0.04^{b}	0.01	0.01	0.01
ER	0.88 ± 0.01^{c}	1.16 ± 0.01^{a}	1.10 ± 0.01^{b}	0.79 ± 0.01^{d}	0.75 ± 0.01^{e}	0.89 ± 0.01^{c}	0.88 ± 0.01^{c}	0.64 ± 0.01^{f}	0.01	0.01	0.01
ES	75 ± 2.53^{e}	50 ± 2.56^{f}	30 ± 2.56^{g}	47 ± 2.56^{f}	129 ± 2.43^{c}	139 ± 2.53^{b}	118 ± 2.53^{d}	156 ± 2.59^{a}	0.01	0.01	0.01

Values within row with different superscript letters differ at P<0.05.

Table 3. Sward height (SWH), pasture production (HO) and quality in TM pasture (A = autumn; W = winter; Sp = spring; Su = summer; Lsmeans ± std. err)

		A	**W**	**Sp**	**Su**
SWH	cm	3.4 ± 0.40 ^{C}	2.7 ± 0.38^{C}	18.0 ± 0.40^{A}	9.7 ± 0.56^{B}
HO	tDM ha^{-1}	0.53 ± 0.04^{C}	0.20 ± 0.04^{D}	1.73 ± 0.04^{A}	0.98 ± 0.06^{B}
DM	%	37.74 ± 1.48^{B}	18.81 ± 1.73^{C}	20.32 ±1.72^{C}	63.44 ± 1.62^{A}
CP	%	10.00 ± 0.43^{B}	17.30 ± 0.50^{A}	10.77 ± 0.50^{B}	7.55 ± 0.47^{C}
NDF	%	73.23 ± 1.11^{A}	55.23 ± 1.30^{C}	59.03 ± 1.30^{B}	72.38 ± 1.22^{A}

Values within row with different superscript letters differ at P<0.001.

Table 4. Milk yield and milk composition of Sarda dairy ewes in TM and CM groups (W = winter; Sp = spring; Lsmeans ± std. err)

	TM		CM		Effect of treatments		
	W	**Sp**	**W**	**Sp**	**S**	**M**	**S x M**
Milk yield (ml/head/day)	871 ± 20	726 ± 21	664 ± 20	586 ± 21	0.001	0.001	0.10
FCM[†] (ml/head/day)	805 ± 22	721 ± 23	603 ± 22	577 ± 23	0.05	0.001	0.21
Fat (%)	6.41 ± 0.08	6.50 ± 0.08	6.26 ± 0.08	6.48 ± 0.08	0.06	0.29	0.40
Protein (%)	5.56 ± 0.04^{a}	5.37 ± 0.04^{b}	5.60 ± 0.04^{a}	5.66 ± 0.04^{a}	0.09	0.001	0.01
Lactose (%)	4.74 ± 0.03^{a}	4.48 ± 0.03^{c}	4.68 ± 0.03^{a}	4.57 ± 0.03^{b}	0.001	0.66	0.05
Urea (mg/dl)	47.4 ± 0.9^{a}	28.1 ± 0.9^{d}	42.2 ± 0.9^{b}	39.3 ± 0.9^{c}	0.001	0.01	0.001

[†] FCM = 6.5% fat corrected milk yield. Values within row with different superscript letters differ at P<0.05.

Table 5. Blood Cortisol level of Sarda dairy ewes in TM and CM groups (A = autumn; W = winter; Sp = spring; Su = summer; Lsmeans ± std. err)

	TM				CM				Effect of treatments		
	A	**W**	**Sp**	**Su**	**A**	**W**	**Sp**	**Su**	**S**	**M**	**SXM**
Cortisol g/dl	3.87 ± 0.3	2.41 ± 0.3	3.33 ± 0.29	2.39 ± 0.41	3.90 ± 0.29	2.14 ± 0.29	3.28 ± 0.29	3.71 ± 0.41	*	ns	ns
∆Cortisol	-0.58 ± 0.4	1.37 ± 0.4	-0.03 ± 0.37	1.04 ± 0.52	-1.28 ± 0.37	1.37 ± 0.37	-0.15 ± 0.37	-0.38 ± 0.52	*	ns	ns

The pasture production and herbage quality show a typical Mediterranean pattern (Table 3). The daily herbage availability (DHA) per ewe ranged between 0.78 ± 0.14 and 6.77 ± 0.15 kg DM head^{-1} in winter and spring, respectively. The crude protein level (CP) was generally low especially in summer. The percentage of energy requirement covered by pasture, estimated as difference between requirements and integration supply, ranged from 25% in autumn to 70% in spring. Milk yield as well as fat corrected milk showed higher values in winter than spring (P<0.001, Table 4). Grazing sheep, during the whole experiment, produced more milk than confined ones (P<0.001). Concerning milk composition no effect of management was detected on milk fat whereas TM group in spring showed the lowest values of milk protein (P<0.01) and milk urea (P<0.001) than the counterparts probably because of an unbalance between energy and protein diet supply (Molle *et al*., 2009). In this period, in fact, although the high DHA per ewe, the quality of the pasture, related to the reproductive phase of grasses, was decreasing and characterised by a low CP content (Table 3). BCS trend in both groups was in line of what usually found for Sarda dairy sheep, with higher values (P<0.05) in TM group in autumn (2.94 ± 0.02 *vs* 2.86 ± 0.02) and spring (2.78 ± 0.02 *vs* 2.68 ± 0.02).

The cortisol level (Table 5) showed values that are within physiological range (Fazio *et al*., 2011). The ∆Cortisol did not show a variation that would justify the discomfort of animals (Caroprese *et al*., 2010). The management did not affect plasma cortisol and its variation but they were significant affected by the season throughout the experiment. In particular a great variation was observed in winter. This finding is in agreement with Al-Busaidi *et al.* (2008), who reported that the increase in cortisol concentrations occurred most commonly during winter than during summer season.

Otherwise the TM group showed an increase of plasma cortisol level (1.04 ± 0.52 μg/dl) during summer while CM group was characterized by a decrease (-0.38 ± 0.52 μg/dl). These results, although almost significant (P = 0.059) and limited in absolute value, could be related to a deficiency of energy and protein supply from pasture (Table 2). Further research are needed to better understand this difference considering also that temperature and THI during summer season were, on average, higher indoor than outdoor (Table 1).

IV – Conclusions

In TM meteorological variability did not affect animal performance whereas grazed pasture exerts a beneficial effect in terms of milk production, even though the low herbage quality offered in spring negatively influenced the milk characteristics. During spring and summer it would be advisable to increase the amount of concentrate supplementation in order to cover the energy and protein unbalance of the pasture. TM results in a higher gross margin than CM due to a lower feed costs, saving the 14% of concentrate and the 84% of hay, and a higher milk production. The good level of self-sufficiency showed by TM system, except in autumn, could be increased by an agronomical improvement of the pasture.

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