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SUMMARY – The trial was carried out on 40 Sardinian grazing sheep divided into four groups of 10 each, during the summer season. The animals of indoor group (S) were fed with vetch-oats hay and commercial concentrate; group (P) was fed only at pasture; group (PR) was fed with pasture and highly degradable concentrate (barley grain and chick-pea); group (PL) was fed with pasture and lowly degradable concentrate (maize and broad bean). Weekly milk yield, body weight and body condition score (BCS) were recorded and milk and blood samples were collected. The sheep behaviour was monitored with scan sampling method. The grazing behaviour was different between groups; P group spent longer feeding on pasture (80%), expressed as percentage of total observation time, than the PR and PL groups (42% and 38% respectively). Milk yield of PL group was higher (P<0.05) than P and PR groups (1.32 kg, 0.92, 1.06 respectively), while no significant differences were observed between PL group and S group. Milk protein, fat, lactose and curd firmness were affected by the nutritional treatments.

Keywords: Grazing, sheep, concentrate, feeding behaviour, milk yield.

RESUME – *"Effet du type de complémentation sur la production laitière, la qualité du lait et le comportement alimentaire de brebis au pâturage au cours de l'été". L'objectif de cette expérience était d'étudier l'influence de différents types de complémentation (concentrés à vitesse de dégradation plus ou moins élevée) sur la production et la qualité du lait et le comportement alimentaire d'ovins au pâturage. L'expérience a été réalisée au cours de l'été, avec 4 groupes comparables de 10 brebis Sardes, en milieu de lactation, pâturant une prairie naturelle de plaine. Les brebis ont été alimentées selon les modalités suivantes : groupe S (en bergerie avec foin ad libitum et 700 g/j de concentré commercial), groupe PS (pâturage seulement pendant 8 h/j), groupe PR (pâturage plus 700 g/j d'orge et pois chiche), groupe PL (pâturage plus 700 g/j de maïs et féverole). Les groupes au pâturage ont montré un comportement alimentaire différent. Le groupe PS a montré un temps élevé de broutement (80%), exprimé en pourcentage du temps total d'observation, par rapport aux groupes PR et PL (42% et 38% respectivement). La production laitière la plus élevée a été enregistrée dans le groupe PL (1,32 kg) (P<0,05) contre 0,92 kg et 1,06 kg dans les groupes PS et PR respectivement. Entre les groupes PL et S, au contraire, des différences significatives n'ont pas été observées. Au niveau qualitatif, des différences ont été observées pour la matière azotée, le taux butyrique, le lactose et la consistance du coagulum. Les différents types de complémentation, en conclusion, ont modifié le comportement alimentaire, la production et la qualité du lait.*

Mots-clés : *Pâturage, brebis, concentré, comportement alimentaire, lait.*

Introduction

The grass availability during the cold and hot weather can constitute a problem for the grazing sheep in Southern Italy. Indeed, during the winter and summer season, ewes have a lower amount of pasture and a worsening of pasture quality showing a unbalanced content of soluble sugar and fibre. Soluble sugar content of grass ranges between 18 and 22% in winter, 12-15% in spring and disappear almost entirely in the summer (Smith, 1973); contrarily fibre content (%NDF) shows the lowest value in winter (around the 35%), intermediate values in spring (42-48%) and the highest values in the summer (around the 60-75%) (Fedele *et al.*, 1993).

During the summer, due to poor quality of the pasture, the use of concentrate supplementation plays a fundamental role for the diet of grazing dairy sheep.

The aim of this study was to investigate the influence of different concentrate source on: (i) performance and milk characteristics of sheep fed both indoor and at pasture and at pasture supplemented with different type of concentrate; (ii) interaction between quality of supplementation and quality of herbage intake; and (iii) capacity of animals to modifying the grazing behaviour in relation to concentrate supplementation.

Materials and methods

The experiment, which lasted 6 weeks, was carried out during the summer (June-July) at the Istituto Sperimentale per la Zootecnia, Foggia, Italy (latitude: 41° 27' 6" and longitude: 15° 33' 5"). Forty Sardinian ewes were used, the animals were divided into four groups of 10 each, which were balanced for body weight, milk yield, and milk protein and fat contents. The animals of indoor group (S) were fed with vetch-oats hay *ad libitum* and 700 g/d of commercial concentrate; group (P) was fed only at pasture; group (PR) was fed with pasture plus 700 g/d supplementation with rapidly degradable concentrate grain (barley and chick-peas); group (PL) was fed with pasture plus 700 g/d of less rapidly degradable concentrate grain (maize and broad beans). The chemical compositions of feeds and supplements are reported in the Table 1.

Table 1. Chemical composition of feeds and supplements administrated in the experimental groups

Group	DM	MJ/kg DM	CP	EE	CF	Ash	NFE	NDF	Ca	P
Grazing	39.6	5.30	9.27	1.42	27.62	6.42	55.27	57.81	0.55	0.25
Vetch-oats hay	83.70	4.09	12.54	1.17	30.36	10.73	45.20	68.75	0.50	0.37
S	88.20	6.46	20.70	4.00	8.70	8.50	58.10	28.34	1.30	0.70
PR	88.50	7.08	20.04	4.03	6.43	3.16	66.34	17.31	0.15	0.39
PL	86.50	6.92	20.58	3.11	6.03	3.07	67.22	18.94	0.08	0.46

The pasture, herbaceous exclusively, was divided into six paddocks, two of which were alternately grazed by each group. The groups at pasture grazed for 8 hours for day, each group being turned off to a new pasture every week. Herbage mass was estimated prior to the beginning of the experiment by cutting 5 randomly selected 1 m^2 sites per pasture followed by clipping to a 2.5 cm stubble height, physical separation, and drying to determine herbage mass of components. Average daily herbage intake was calculated as the difference between two consecutive sward measurements divided by ewe number x grazing day period (Frame and Hunt, 1971; Andrighetto, 1986).

Weekly milk yield, body weight and body condition score (BCS) were recorded and milk and blood samples were collected. Milk samples were analysed for pH, fat, protein, lactose somatic cell count and rheologic parameters. Blood samples were collected from the jugular at 8:00 h a.m., before supplementation, and were analysed for metabolic profile (NEFA, glucose, cholesterol, triglycerides, urea, albumin, globulin, total protein, ALT, AST, GOT, GPT and total bilirubin).

Grazing behaviour of the P, PR and PL groups, was monitored by method "Scan Sampling" (Gavinelli *et al.*, 1994). Statistical analyses was performed using the GLM procedures of SAS software (SAS, 1999).

Results and discussion

Botanical composition of pasture

Botanical composition of pasture (Table 2), in the summer season in comparison to spring season, (Annicchiarico *et al.* 2004), showed the scarce presence of grasses and legumes. Indeed, during the summer season we observed the lower amount of grasses (12%) and legumes (31%) than the "other families" (composite and other aromatic plants, 57%) which have been largely used by the animals in agreement with Fedele *et al.* (1993) and Rubino *et al.* (2002) .

Table 2. Botanical composition of pasture (%) in different seasons

Species	Winter	Spring	Summer
Grasses			
Hordeum v.	3.00	10.00	
Lolium perenne	-	3.75	2.00
Festuca arundinacea	11.00	10.50	10.00
Legumes			
Trifolium pratense	7.00	9.00	10.00
Medicago lupolina	70.00	48.00	20.00
Onobrychis vicefolia	-	0.50	1.00
Forbs			
Malva sp.	1.00	5.00	25.00
Cirsium sp.	2.00	2.75	20.00
Matricaria sp.	2.00	5.00	12.00
Lamium sp.	1.00	3.00	-
Euphorbia minor	1.00	-	-
Capsella sp.	2.00	2.50	-
Total species	100.00	100.00	100.00

Grazing behaviour

The grazing behaviour of sheep was different between groups being accounted for concentrate source. P group spent longer feeding on pasture (80%), expressed as percentage of total observation time, than the PR and PL groups (42% and 38% respectively). This behaviour influenced the intake to the pasture, indeed, we observed that the group P ingested around 800 g/DM/d in comparison to 500 g/DM//d and 600 g/DM/d of the group PR and PL respectively. It seems that ewes spent longer feeding time looking for plant parts with higher degradability (Claps *et al.* 2001).

We assume that the reducing grazing time could be due to the typical effect of substitution of the concentrate supplementation.

With reference to the choice of species, the ewes have shown different behaviour in relation to the phenological stadium of the plants in agreement with Nolan and Nastis (1997). In fact, ewes appreciated the grasses in the vegetative stadium but refused them in reproductive stage; while in this phenological stadium, we observed, by direct observation before and after grazing use, a good preference to aromatic plants (*Malva* sp.*, Matricaria* sp.*, Trifolium pratense*). Probably, this could be explained with the increase of importance of such plants in the botanical composition of the pasture and to the need of the animals to search plants with a greater content of water. As reported by Morand-Fehr *et al.* (1993), in experiments on goats, the optimal content of dry matter of the grass should be between 20 and 25%.

Milk yield and quality

Table 3 illustrates milk yield and milk quality (as defined by nutritional chemical composition, somatic cell count and rheological parameters) data.

The group PL had significantly ($P<0.01$) higher milk yield than PR and P groups (1.32 *vs* 1.06 and 0.92 kg); moreover PL group, had higher milk yield than group fed indoor (1,32 *vs* 1,25 kg).

The fat content, as expected, showed a negative correlation with milk yield. In fact, in the PL group, that showed the highest milk yield, we found lower fat content than other groups (<0.05).

We observed in indoor (S) and pasture groups (PL) similar milk yield but significantly difference ($P<0.05$) on fat content (6.54% *vs* 6.00% respectively), this is probably due to the lower content in fibre of the diet as consequence of the lower ingestion of dry matter from the pasture.

Table 3. Milk yield, chemical composition and rheological parameters in different feeding systems

	S	P	PR	PL
Milk yield (kg)	1.25[a]	0.92[b]	1.06[b]	1.32[a]
Fat (%)	6.54[a]	6.81[a]	6.54[a]	6.00[b]
Protein (%)	5.40[b]	5.07[c]	5.76[a]	5.35[b]
Lactose (%)	4.86[b]	4.76[c]	4.88[b]	5.03[a]
SCC (x1000)	592[b]	964[b]	1,890[a]	461[b]
pH	6.59[b]	6.64[a]	6.59[b]	6.59[b]
r	16.81	17.55	17.71	17.72
K20	4.02	4.30	4.16	4.20
A30	45.62[b]	50.10[ab]	54.00[a]	54.88[a]

[a,b,c]: Means with different superscript letter in the same row differ significantly (P<0.05)

The protein content, as expected, was significantly higher (P<0.05) in PL and PR groups than P group; moreover milk protein content in supplemented groups, results more elevated (P<0.05) in PR than PL and S groups (5,76% *vs* 5,35 and 5,40). Lactose, was significantly higher (P<0.05) in the group PL in comparison to PR, S and P groups (5.03% *vs* 4,88%, 4,86% and 4,76%).

Our results suggest that the milk quality of the PL group showed best interaction between pasture composition and type of concentrate. In Mediterranean area pasture quality is characterized by a high dry matter and fibre content in summer period. It could be related to the synchronism between energetic availability and availability of the protein source and, therefore, to the best use at intestinal level (Sinclair *et al.*, 1993). Milk of the group PR showed the highest somatic cells count (P<0.01). This elevated value, above the data reported in literature, suggested a inflammatory status of the animals that have been amplified by higher average temperatures than normal values recorded during the season (superior to 26°C).

The group P showed higher pH value (P<0.05) than other groups. Anyway we didn't found significantly differences in the clotting (r) and in the curd firming time (K20), while the supplemented grazing groups (PR and PL) showed higher (P<0.05) curd firmness value (a30) than indoor group(S).

Metabolic parameters

In Table 4 are reported metabolic parameters data. The group indoor (S) and the group P showed values of glucose, NEFA and cholesterol indicating negative energy balance of the animals, while the values of PR and PL groups showed positive energy balance. In fact, the groups S and P showed, significantly (P<0.05), lower glucose value than PR and PL groups (50.93 and 50.83 *vs* 55.83 and 57.00 mmol/dl).This data seems to be in conflict with the data of body weight and BCS (data not shown) which recorded an inverse trend, it is known that heat stress condition and inflammatory state could modify energetic and proteic metabolic parameters, as reported by Lacetera *et al.* (1996) and Ronchi *et al.* (1997). Triglicerid value didn't show any significant differences among groups.

The value of urea were in the range reported by Bertoni (1996) and reflected the protein content of diet. In fact, the supplemented groups showed values of urea more elevated, (P<0.05) than the not supplemented group (P).

The assessment of the liver functionality is evaluated by the metabolic-synthetic capacity and the test of the function excretion – bilious, Braun *et al.* (1986). We found lower values (P<0.05) of albumins in the supplemented grazing groups than S and P groups. That could be due to a protein syntheses of the acute phase, even if this is not confirmed by the levels of the liver enzymes (GGT, ALP). Moreover, we found higher values of AST than that reported in bibliography by Giorgetti *et al.* (1982). It could be due to a sudden and elevated motor activity (Bertoni *et al.* 2001).

Table 4. Pattern of some blood metabolites in different feeding systems

Parameters	S	P	PR	PL
Glucose (mmol/dl)	50.93[b]	50.83[b]	55.83[a]	57.00[a]
Cholesterol (mmol/dl)	66.06[a]	68.33[a]	56.11[b]	57.25[b]
NEFA (mmol/dl)	0.49[a]	0.34[b]	0.30[bc]	0.19[c]
Triglycerides (mmol/dl)	14.13	13.66	13.58	12.00
Urea (mmol/l)	60.00[a]	45.00[b]	54.80[a]	56.25[a]
Albumins (g/dl)	4.06[a]	4.02[a]	3.73[b]	3.84[b]
Globulins (g/dl)	3.14	3.04	2.77	2.93
Total protein (g/dl)	7.21[a]	7.07[a]	6.50[b]	6.77[ab]
ALP (U/l)	153.13	146.80	136.52	172.41
ALT/GPT (U/l)	15.93[ab]	17.33[a]	13.44[b]	14.58[ab]
AST/GOT (U/l)	98.26	93.93	93.44	102.66
AST/ALT	6.17	5.42	6.95	7.04
Total bilirubin	0.49[a]	0.42[a]	0.31[b]	0.33[b]
GGT (U/l)	70.80	70.93	70.52	67.75

[a,b,c]: Means with different superscript letter in the same row differ significantly (P<0.05).

Conclusions

The concentrate supplementation modified grazing behaviour of the ewes during summer season. Indeed we observed a reduction of the time at grazing and the relative search of plants. Moreover, the source of concentrate supplementation interacts in different way with the pasture available, as consequence we found different productive response from the animals.

During the summer season, it seems that the use of a concentrate slowly degradable better combine with the available pasture in the sub-arid environments of southern Italy than a concentrate rapidly degradable. The metabolic profile, used as helpful tool to underline states of feeding excesses/deficiencies and the presence of metabolic disorders, results of difficulty interpretation in the summer. Indeed, in this season it should be necessary to consider, also, the effect of the heat stress on the parameters of the energetic metabolism.

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