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To cite this article: Massimo Todaro, Adriana Bonanno, Gabriele Tornambè, Antonino Di Grigoli, Maria Luisa Scatassa & Pietro Giaccone (2009) Utilization of mulberry leaves (*Morus latifolia* cv. Kokusou 21) in diets for dairy ewes, *Italian Journal of Animal Science*, 8:sup2, 438-440, DOI: [10.4081/ijas.2009.s2.438](https://doi.org/10.4081/ijas.2009.s2.438)

To link to this article: <http://dx.doi.org/10.4081/ijas.2009.s2.438>



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Published online: 07 Mar 2016.



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# Utilization of mulberry leaves (*Morus latifolia* cv. Kokusou 21) in diets for dairy ewes

Massimo Todaro<sup>1</sup>, Adriana Bonanno<sup>1</sup>, Gabriele Tornambè<sup>1</sup>,  
Antonino Di Grigoli<sup>1</sup>, Maria Luisa Scatassa<sup>2</sup>, Pietro Giaccone<sup>1</sup>

<sup>1</sup>Dipartimento di Scienze Entomologiche, Fitopatologiche, Microbiologiche agrarie e Zootecniche,  
Università di Palermo, Italy,

<sup>2</sup>Istituto Zooprofilattico Sperimentale della Sicilia, Palermo, Italy

*Corresponding author:* Massimo Todaro. Dipartimento S.En.Fi.Mi.Zo., Sezione di Produzioni Animali, Facoltà di Agraria, Università di Palermo. Viale delle Scienze, 90128 Palermo, Italy - Tel. +39 091 7028861 – Fax: +39 091 7028873 - Email: zootmax@unipa.it

**ABSTRACT** - Twelve Valle del Belice lactating ewes were divided into three homogeneous groups and fed *ad libitum* the following diets in a 3x3 Latin square design: sulla hay (HA); sulla hay and Mulberry leaves (M. leaves) (HM); M. leaves (MU). DM intake of MU ewes was lower than that of HM ewes, with an intermediate level for HA ewes. HM ewes showed to prefer M. leaves to hay, but their need to balance the high protein and low NDF contents of M. leaves by eating hay also emerged. Milk yield increased as the dietary content of M. leaves increased. In addition, the use of HM and MU diets led to higher milk fat and urea content in comparison with the HA diet. The results confirmed that M. leaves are a suitable fresh feeding source for sheep, and suggested to use them in association with fibre-rich feeds.

*Key words:* Mulberry leaves, Dairy sheep, Feed intake, Milk.

**Introduction** - Mulberry is a shrub or a tree used traditionally for feeding the silkworm in various countries. Studies on the use of shrubs, aimed to overcome the summer shortage of green forage availability in central Italy, started in 1980, with comparisons among different species in artificial plantations (Angeloni, 2000). The only suggestion of utilizing mulberry for direct grazing came from Talamucci and Pardini (1993) and Talamucci *et al.* (2000), who proposed a complementary association with clover (*Trifolium subterraneum*) for sheep and cattle grazing in Tuscany, Italy. This type of forage plays an important role in semi-arid environments in many areas of the world, where it can be utilized as main or secondary feed source in periods when the availability of conventional forages is low. Thus, mulberry could be considered a “strategic” plant to be used only in critical seasons and in semi-arid environments, such as Sicily. A previous investigation (Todaro *et al.*, 2007) showed that M. leaves and green apices are preferred by sheep to other feeds (vetch hay and oat grains) and are characterized by high digestibility coefficients (OM 78.2%; CP 79.2%; NDF 77.8%; cellulose 88.3%) and high nutrient value (NE<sub>L</sub> 1.73 Mcal/kg DM). The absence of anti-nutritional factors or toxic compounds (Sanchez, 2000) and an unfavorable high Ca:P ratio for fertility (Singh and Makkar, 2002) are also reported. The aim of this work was to evaluate the utilization of M. leaves as feed for lactating ewes and to investigate their effects on voluntary intake, milk yield and composition.

**Material and methods** - A total of 12 Valle del Belice breed ewes, averaging 90±26 days in milk and 1352±208 g/day of milk yield, were blocked on parity, days in milk and milk yield, and randomly assigned to three groups subjected to three feeding treatments, in a 3x3 Latin square design with 14 days experimental periods that comprised of a 9 days adjustment period and a 5 days recording period.

Ewes were housed in individual pens (2x2m) and, after the morning hand-milking (7.00 a.m.), were fed *ad libitum* with sulla hay (HA), sulla hay and M. leaves (HM) or M. leaves (MU). M. leaves were harvested daily in the morning. After the afternoon milking (4.00 p.m.), each ewe received 250 g/d of barley, 50 g/d of tickbean and 500 g/d of sulla hay. During the last 5 days of each experimental period, the offered and residual feeds and milk yield were individually measured and sampled. Analysis for DM, crude protein, ether extract, ash, and structural carbohydrates were carried out on feed samples. Milk was analysed for fat, protein, casein, lactose and somatic cells count (SCC) by infrared methods (Combyfoss 6000, Foss Italy), urea by an enzymatic method using differences in pH (CL10 instrument, Eurochem, Italy), pH by a pH-meter and clotting ability by measurements of clotting time ( $\tau$ , min), curd firming time ( $k_{20}$ , min) and curd firmness ( $a_{30}$ , mm) (Formagraph instrument, Foss Italy). Data were statistically analysed by MIXED procedure of SAS 9.1.2, using a model with feeding treatment as fixed effect, and experimental period and ewe as random effects. LS means differences were assessed by the Student's *t* test.

**Results and conclusions** - The chemical composition of offered feeds is shown in Table 1. M. leaves composition resulted in accordance with those reported by other authors (Sanchez, 2000; Todaro *et al.*, 2007; Kandylis *et al.*, 2009). The high protein and low fibre fractions content confirmed that this forage can be considered a protein-rich feed, especially if compared to other foliages. The ether extract and ash contents were high, in line with the international literature on M. leaves.

DM intake of MU ewes (Table 2) was significantly lower than that of the HM

group, with an intermediate level for the ewes receiving only hay as forage source (HA group). M. leaves constituted the 45% and the 65% of the total DM intake in HM and MU groups, respectively.

Table 2. Effect of feeding treatments on feed and nutrients intake of lactating ewes (reported as g/d *per head*; % of total DM intake in parenthesis).

	HA	HM	MU	SE
Dry matter	2121ab	2149a	2054b	26.58
<i>Mulberry leaves</i>	0	971 (45.2)	1344 (65.4)	
<i>Hay in the morning</i>	1426 (67.2)	472 (22.0)	0	
<i>Hay in the evening</i>	427 (20.1)	438 (20.4)	443 (21.6)	
<i>Grains</i>	268 (12.6)	268 (12.5)	268 (13.0)	
Crude protein	328A	395B	397B	4.44
Ether extract	30A	58B	69C	0.86
NDF	1013A	721B	591C	14.58
Ash	201A	224B	227B	3.39
Water	6675A	5300B	4679C	183

A, B, C:  $P < 0.01$ ; a, b:  $P < 0.05$ .

Table 1. Chemical composition of offered feeds (% DM).

	Mulberry leaves	Sulla hay	Barley	Tickbean
DM (% as fed)	25.98	90.78	89.35	89.35
Crude protein	21.05	11.88	14.22	25.88
Ether extract	4.36	1.22	1.94	1.25
NDF	22.88	54.75	20.29	17.14
ADF	19.72	48.50	11.50	14.14
ADL	3.24	9.77	1.74	1.39
Cellulose	14.80	38.35	9.28	12.74
Hemicelluloses	3.17	6.25	8.79	3.01
Ash	13.31	9.39	3.47	3.27

during the diurnal milking interval, the voluntary intake of M. leaves of HM ewes, which were in a free choice condition, was more than double of that of hay; this result confirmed the good palatability of M. leaves, which were preferred to than hay, and also shows the need of the ewes to balance the dietary nutrients by eating hay, with consequent increase of NDF intake in comparison with MU ewes. On the other hand, MU ewes had the same protein intake of HM ewes, irrespective of their higher intake of protein-rich M. leaves; this feeding behaviour implies that MU ewes were able to select the less proteic

Table 3. Effect of feeding treatments on milk yield and composition of lactating ewes.

	HA group	HM group	MU group	SE
Milk yield (g/d)	974A	1026B	1095C	15.75
Fat (%)	6.12A	6.54B	6.40AB	0.11
Protein (%)	5.34	5.28	5.26	0.04
Casein (%)	4.10	4.09	4.20	0.07
Casein/fat ratio	0.67	0.64	0.67	0.03
Urea (mg/dl)	35A	40B	42B	0.78
Lactose (%)	4.68A	4.60B	4.61B	0.02
SCC (Log <sub>10</sub> n/ml)	5.81	5.92	5.77	0.08
pH	6.63	6.59	6.65	0.04
r (min)	18.02	19.74	19.77	0.76
k <sub>20</sub> (min)	2.01	1.70	1.40	0.33
a <sub>30</sub> (mm)	60.60	58.86	56.52	3.12

A, B, C:  $P < 0.01$ .

verse relationships was observed between water consumption and dietary incidence of green leaves of mulberry. Milk yield improved when the dietary content of M. leaves increased (Table 3). With regard to milk composition (Table 3), diets based on M. leaves were responsible, in comparison with HA diet, of an increase in fat and urea content in milk. Milk fat increase was presumably linked to either higher lipids content and good fibre digestibility of M. leaves. Instead, milk urea increase was due to higher protein intake by HM and MU ewes. In conclusions, the M. leaves seem to represent a suitable feeding resource to be supplied to sheep in periods of fresh forage shortage, even though in association with other fibre-containing feeds; the possibility of their direct exploitation by grazing needs be investigated.

The Authors wish to thank the "Istituto Sperimentale Zootecnico per la Sicilia" and the Prof. Angela Sinacori for the valuable support.

The research was supported by POR Sicilia 2000-2006, Misura 3.13.

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fractions of mulberry biomass, such as the petioles rather than the leaves, for avoiding an excessive nitrogen intake. In this regard, it should be noted that it has been suggested to use M. leaves only as a part of livestock diets (Singh and Makkar, 2002). As expected, ewes receiving M. leaves showed higher protein, ether extract and ash intake, and lower NDF intake than ewes fed the hay-based diet. Moreover, an in-