

*Original Scientific Article***MANAGEMENT PRACTICES AND MILK PRODUCTION IN DAIRY DONKEY FARMS DISTRIBUTED OVER THE ITALIAN TERRITORY**

Francesca Dai<sup>1</sup>, Giulia Segati<sup>1</sup>, Emanuela Dalla Costa<sup>1</sup>, Faith Burden<sup>2</sup>,  
Andrew Judge<sup>2</sup>, Michela Minero<sup>1</sup>

<sup>1</sup>*Università degli Studi di Milano, Dipartimento di Medicina Veterinaria,  
via Celoria 10 20133 Milano, Italy*

<sup>2</sup>*The Donkey Sanctuary, Sidmouth, Devon, EX10 0NU, UK*

Received 21 December 2016; Received in revised form 22 February 2017; Accepted 12 March 2017

**ABSTRACT**

Limited information is available about the actual management characteristics of dairy donkeys in Southern Europe. The aim of the present study is to describe animal management of dairy donkey farms in Italy. Twelve farmers were asked to answer a questionnaire on the management of their animals and their farms distributed over the Italian territory. Six farms grouped their animals in paddocks according to the production characteristics (e.g. lactating, dry, stallions); three farms housed the stallions in single boxes. Most of the visited farms were family run and the number of animals cared for by a single person varied from five to 103 animals. All the farms but one performed mechanical milking with a modified goat milkmaid. Vaccinations were regularly performed only on two farms. All the foals received colostrum and suckled from their own mothers. Foals were nursed by their mother until 6-12 months old. During the separation period before milking, foals were usually (83%) housed in paddocks near their mothers with the possibility of visual and/or tactile contact, however such separations could be for up to 12 hours (17%). Even though the assessed sample was small, considerable differences were seen between farms, likely due to lack of uniform information available for the farmers. The adoption of scientific based procedures is suggested in order to improve both animal welfare and milk quality.

**Key words:** donkey, milk, animal welfare, farm management

**INTRODUCTION**

Thanks to the growing interest in donkey milk for paediatric nutrition (1, 2, 3) and cosmetics, a number of new small-scale donkey farms have opened in South Europe (4), mostly in Italy. The production systems adopted appear to differ hugely across farms, ranging from semi-intensive to semi-extensive systems. Limited information is available about the management characteristics of these farms and preliminary investigations (5) have

highlighted a number of potential issues relating to the management and the welfare of dairy donkeys (6). The aim of the present study is to collect data regarding dairy donkey management and milk production in farms distributed over the Italian territory.

**MATERIAL AND METHODS***Farms*

Twelve dairy donkey farms, selected with a blocked randomization process matched for the North-Centre-South parts of Italy, were visited between June and September 2015. The selected regions were Lombardia, Abruzzo and Sicilia. Local authorities provided the contact details of dairy donkey farmers in their area. Farmers were contacted over the phone or by e-mail by researchers to introduce the project and to plan an on-farm

*Corresponding author:* Dr. Francesca Dai, DVM  
*E-mail address:* francesca.dai@unimi.it  
*Present address:* Università degli Studi di Milano,  
Dipartimento di Medicina Veterinaria, via Celoria 10, 20133 Milano, Italy  
*Phone:* +39 0250318033 *Fax:* +39 0250318030

**Copyright:** © 2017 Dai F. This is an open-access article published under the terms of the Creative Commons Attribution License which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

**Competing Interests:** The authors have declared that no competing interests exist.

**Available Online First:** 6 April 2017

**Published on:** 15 October 2017

<https://doi.org/10.1515/macvetrev-2017-0016>

visit. All the contacted farmers participated on a voluntary basis. The number of donkeys per farm varied between 19 and 170 (mean=54,50±47,86).

### Questionnaires

Farmers were asked to fill out two questionnaires: the first one on the animal management and the second on milk production. The animal management questionnaire contained questions about nutrition, health management, housing, final destination of donkeys and foals (e.g. pet, work, meat production), weaning methods, management of male donkeys intended for meat production and distances travelled to reach slaughter. The questionnaire on milk production contained questions about average milk production per farm, use of milk (e.g. human consumption, cosmetics, processing into other food products such as ice-cream or sweets), sales channels (e.g. on the farm, consortium, supermarket, independent store, specialist or non-specialist store, restaurant, other), terms of sale (e.g. fresh raw milk, pasteurized milk, frozen milk, lyophilized milk), methods to reduce bacteria, marketing channels and consumers' characteristics.

Following the method adopted in (7) to evaluate the welfare of donkeys kept for different purposes,

the AWIN welfare assessment protocol for donkeys (8) was used, in the present study to evaluate the welfare of dairy donkeys. Results of the welfare assessment were partially published in (6).

### Data collection and data analysis

Data was collected using Open Data Kit application (developed by the University of Washington, Department of Computer Science and Engineering), a digitalized system available for Android devices (9). Data was downloaded from the server to a Microsoft Excel file (Microsoft Corporation 2010) and subsequently descriptive statistical analysis were performed with SPSS 22 statistical package (IBM SPSS Statistic 2013).

## RESULTS

### Animal management questionnaire

The number of donkeys per farm varied from 19 to 170 donkeys (mean 54,50±47,86). Of a total of 244 females, 120 were lactating and 124 were dry jennies, aged between 36 and 288 months (mean=88,87). A total of 27 stallions, aged between 24 and 180 months (mean=90,46), lived on the

**Table 1.** Management of jennies

Management question	Score	% of Farms	
<b>Age at first birth</b>	3 years	63,6	
	4 years	36,4	
<b>Training</b>	Visual contact with other jennies and manipulation	91,7	
	No training	8,3	
<b>Final destination</b>	Animal Assisted Therapy	33,3	
	Trekking	8,3	
	Pet	25,5	
	Sold as broodmares	8,3	
	Slaughterhouse	8,3	
	NA	16,6	
<b>Nutrition of lactating jenny</b>	Pasture	100	
	Hay	100	
	Barley	58,3	
	Concentrate	Oat	8,3
		Compound feed	33,4
	Salt supplement	66,7	
<b>Nutrition of dry jenny</b>	Pasture	91,6	
	Hay	100	
	Barley	25	
	Concentrate	Compound feed	25
		Salt supplement	57,3

**Table 2.** Management of stallions

Management question	Score	% of Farm	
<b>Housing</b>	Group with females	50	
	Individually	41,7	
<b>Social interactions</b>	Full social interactions	50	
	Visual contacts	41,7	
<b>Nutrition</b>	Pasture	66,7	
	Hay	91,7	
	Concentrate	Barley	16,7
		Oats	16,7
		Compound feed	33,3
	Salt supplement	41,7	
Other supplements	8,3		

visited farms; one farm had no stallions, since they shared it with another farm. Most of the farms (N=6) had mixed breed donkeys, while the remaining ones kept only one breed (e.g. Grigio Siciliano, Sardo, Martina Franca, Ragusana and Amiata). Donkeys were usually kept semi-extensively (pasture with shelters) all day long, with the exception of two farms where they were stabled during the night. Shelters were not present on three farms. Except for three farms where donkeys were kept all together, animals were grouped according to their production characteristics: in particular, lactating and dry jennies were usually separated to better manage feeding and milking procedures. Results of jennies and stallions management are reported in Table 1 and Table 2, respectively.

A total of 169 foals (102 female and 67 male) were present on the assessed farms. No farms used artificial milk, therefore, the foals received colostrum from and were nursed by their mother until 6-12 months old (mean=8,83±2,12). Additional feed was introduced between 0 and 12 months (mean=6,58±3,85). The weaning process differed from farm to farm: on five farms foals remained with their mother after weaning and were not separated; on two farms foals were weaned one at a time, starting with the oldest, which created a new group of yearlings on the farm; on the remaining farms (N=5), one jenny was taken away at a time letting the group settle down again until the next jenny was removed. Donkeys were milked on 11 of 12 farms. For the milking procedures, foals were separated from their mothers four (N=3), six (N=5) or 12 hours (N=3) before milking. During the separation period, foals were usually housed in paddocks near their mothers (N=10), with the possibility of visual and/or tactile contact. In the

remaining farm, foals were totally separated from their mothers with no visual or tactile contact possible. Male foals not intended for reproduction were sold directly to the slaughterhouse (N=6), to other farms where they were going to be used for assisted therapy (N=3) or to private owners as pets (N=2). The remaining farm adopted all the possibilities mentioned above. Foals were sold between three and 18 months (mean=10,42±3,73).

Most of the visited farms (N=10) were family run, only two farms had employees. The number of donkeys cared for by a single person varied from five to 103 animals (mean=38,33±33,19). Night care was guaranteed on 10 farms. The veterinarian was called every month for routine checks by three farmers, while the other farmers called the vet only when needed. Vaccinations were regularly performed only on two farms; most (N=10) of the interviewed farmers did not consider vaccinations useful for the health of donkeys. Nine farmers regularly dewormed young and adult donkeys, one farm dewormed just foals and only two farmers did not consider it necessary to deworm animals. Two farmers called the farrier every three months, six farmers less frequently, while four farmers never called the farrier. Most of the farmers declared that they had the ability to perform hoof correction autonomously.

#### *Milk production questionnaire*

Eleven farms produced donkey milk for sale (mean milk production per jenny/day was 1355±509 ml); the remaining farm was brand new and it was not yet producing nor selling milk. Milk was intended for human consumption (N=11), eight farms also produced cosmetics and four additionally transformed milk into confectionery products. The

main sales channel was direct to the consumer (N=11), other options were a small consortium (N=1) and a non-specialised shop (N=1). The marketing channels were websites and social networks (N=8) and word of mouth (N=8). None of the sampled farms sold milk to paediatric wards. Consumers mostly bought fresh milk directly on farm more than once a week (N=5) or less frequently (N=6). The answers to the question “what influences consumers’ purchasing decisions?” were rather vague and in most cases could be interpreted as the need to drink donkey milk because of health reasons. All the consumers, as reported by farmers, were children in the household. All the farms but one performed mechanical milking, the remaining one did manual milking; machines used were modified from a goat milkmaid. Nine farms milked once a day, the remaining one milked upon request. All the farmers adopted a method of cleaning and disinfection of the teats: damp cloth, disinfectant or pre-dipping. Five farms performed pasteurization, four refrigerated the milk, one farm performed filtering and one farm froze the milk. All the farms but one periodically carried out milk analysis, with eight farms searching for somatic cells (22916,7±34851,5 SSC/ml) in addition to bacterial count (134166,7±229383,3 cfu/ml). All the farmers declared not to use any drugs on lactating donkeys. It remains to be investigated if and how lactating donkeys were treated when ill.

## DISCUSSION

The findings of the present study show that the assessed Italian dairy donkey farms do not follow uniform procedures for the management of animals (nutrition, stallion keeping, mother-foals separation and health care) nor milk production.

Considerable differences between farms were found in concentrate feed of both dry and lactating jennies, e.g. feedstuffs and amount of feed per day. As already highlighted by several authors (10, 11, 12, 13), these differences could be interpreted in the light of the lack of scientific knowledge on donkey nutrition in different physiological states, such as lactating or pregnant jennies. On average, the assessed animals enjoyed a good nutritional status (with 80.2% of the donkeys having a Body Condition Score of 3 on a 5-point scale), however dry jennies and stallions seem to require more attention regarding their nutrition (6). In the assessed sample, stallions were often singly stabled, meaning that they enjoyed only

visual contact with other donkeys. It is well known that donkeys are highly social animals (14, 15); thus contact with other conspecifics plays an important role in maintaining them in good welfare condition. Furthermore, Dai et al. (6) reported that stallions kept in single boxes have less possibility to move freely, thus increasing the frequency of hoof problems. In the visited farms, daily milking number, frequency as well as the duration of mother-foals separation before milking varied based on farmer’s personal experience. D’Alessandro and Martemucci (16) reported that the daily milking regimen influences the milk yield and the udder health condition. Furthermore, 3 hours was described as the ideal interval milking to obtain the best organoleptic characteristics of donkey milk (17). In the same study, intervals of 5 and 8 hours were found to cause a decrease in milk fat and lactose content. Moreover, donkeys are considered a follower species, which like to keep their foals nearby until 10 months of age (18). It is likely that the separation between jenny and foal is stressful and the duration of this period can play a crucial role. For this reason, farmers kept the foals in a group and in visual contact with their mothers. However, further studies are needed to better understand the effect of milking intervals (4, 6 and 12 hours) not only on milk characteristics, but also on the behaviour of the animals. In terms of health care, different approaches were followed and the need for more uniform procedures is clear: as donkey milk is mainly consumed by allergic infants and children, ensuring high standards of animal health is of paramount importance. Prevention being better than cure, all donkeys involved in milk production should have routine veterinary checks, deworming programmes and regular vaccination schedules (19, 20). Regular health checks have been shown to have a demonstrable impact on both welfare and productivity of the donkeys (21).

Milk is sold raw, refrigerated, frozen, pasteurized or lyophilized and it is not unusual that milk processing methods differ from farm to farm, depending on the farm area. It is recognised that only few Regions adopt a specific legislation for producing and selling donkey milk (5, 22, 23). Furthermore, little information is available on the best solutions for donkey milk processing (24, 25, 26) and more studies are needed to clarify how these procedures modify milk properties in terms of nutritional value, food safety, and organoleptic characteristics.

## CONCLUSION

To date, this was the first study investigating different aspects of donkey milk production. Even though the sample of dairy donkey farms assessed was small, considerable differences were found in management and milk processing. These differences are likely due to the lack of uniform information available for the farmer. The adoption of scientific based procedures in both management of donkeys and milk processing is suggested in order to improve both animal welfare and milk quality raising the consumer trust in this niche product.

## CONFLICT OF INTEREST STATEMENT

The authors declared that they have no potential conflict of interest with respect to the authorship and/or publication of this article

## ACKNOWLEDGEMENT

The authors would like to thank all the public health authorities and the farmers for their important contribution. Special thanks go to Dr Matteo Chincari and Dr Lorenzo Ferrari for their help in data collection. The project “A pilot investigation to determine welfare standards on milk/meat donkey farms in Italy and potentially influence their main drivers” has received funding from The Donkey Sanctuary, Sidmouth, Devon, EX10 0NU, UK.

## REFERENCES

- Salimei E., Fantuz F., Coppola R., Chiofalo B., Polidori P., Varisco G. (2004). Composition and characteristics of ass's milk. *Anim Res.* 53, 67–78. <https://doi.org/10.1051/animres:2003049>
- Tafaro A., Magrone T., Jirillo F., Martemucci G., D'Alessandro A.G., Amati L., Jirillo E. (2007). Immunological properties of donkey's milk: its potential use in the prevention of atherosclerosis. *Curr Pharm Des.* 13, 3711–3717. <https://doi.org/10.2174/138161207783018590> PMID:18220810
- Monti G., Bertino E., Muratore M.C., Coscia A., Cresi F., Silvestro L., Fabris C., Fortunato D., Giuffrida M.G., Conti A. (2007). Efficacy of donkey's milk in treating highly problematic cow's milk allergic children: An in vivo and in vitro study. *Pediatr Allergy Immunol.* 18, 258–264. <https://doi.org/10.1111/j.1399-3038.2007.00521.x> PMID:17433003
- Faye B. (2016). Food security and the role of local communities in non-cow milk production. In: E. Tsakalidou, K. Papadimitriou (Eds.), *Non-bovine milk and milk products* (pp. 1–13). Academic Press. <https://doi.org/10.1016/b978-0-12-803361-6.00001-6>
- World Horse Welfare, Eurogroup for Animals (2015). *Removing the blinkers: The health and welfare of european equidae in 2015*.
- Dai F., Segati G., Dalla Costa E., Burden F., Judge A., Minero M. (2016). Italian donkey milk farms: a snapshot of welfare conditions. In: S. Heat, S. McCulloch, D. Jacinto, G. da Graça Pereira (Eds.), *European Congress Animal Welfare & Behaviour Medicine* (p. 31). Cascais, Portugal: PsiAnimal.
- Dai F., Dalla Costa E., Murray L.M.A., Canali E., Minero M. (2016). Welfare conditions of donkeys in Europe: initial outcomes from on-farm assessment. *Animals* 6 (5). <https://doi.org/10.3390/ani6010005>
- AWIN (2015). AWIN welfare assessment protocol for donkeys. [https://doi.org/10.13130/AWIN\\_DONKEYS\\_2015](https://doi.org/10.13130/AWIN_DONKEYS_2015)
- Dai F., Dalla Costa E., Battini M., Barbieri S., Minero M., Mattiello S., Canali E. (2014). An innovative tool for on-farm data collection and information sharing. In: L. Mounier, I. Veissier (Eds.), *Proceedings of the 6th International Conference on the Assessment of Animal Welfare at Farm and Group Level* (p. 153). Wageningen Academic Publishers.
- Salimei E. (2011). Animals that produce dairy foods: donkey. In: J. Fuquay, P. Fox, P. McSweeney (Eds.), *Encyclopedia of dairy science, Vol 1* (pp. 365–373). San Diego, CA: Academic Press. <https://doi.org/10.1016/B978-0-12-374407-4.00041-8>
- Salimei, E., Fantuz, F., Varisco, G., Maglieri, C., Polidori M. (2005). Different fibre sources in dairy ass's diet: Effects on milk yield and composition. *Ital J Anim Sci.* 4 (Suppl. 2): 430–432. <https://doi.org/10.4081/ijas.2005.2s.430>
- Burden F.A., Du Toit N., Hazell-Smith E., Trawford A.F. (2011). Hyperlipemia in a population of aged donkeys: description, prevalence, and potential risk factors. *J Vet Intern Med.* 25 (6):1420–1425. <https://doi.org/10.1111/j.1939-1676.2011.00798.x> PMID:22092637
- Smith D., Wood S. (2008). Donkey nutrition. In: E.D. Svendsen, J. Duncan, D. Hadrill (Eds). *The professional handbook of the donkey*, 4th ed. (pp. 10–27). Yatesbury, Wiltshire, UK: Whittet Books.

14. Murray, L.M.A., Byrne, K., D'Eath, R.B. (2013). Pair-bonding and companion recognition in domestic donkeys, *Equus asinus*. *Appl Anim Behav Sci.* 143 (1): 67–74.  
<https://doi.org/10.1016/j.applanim.2012.11.005>
15. Whiteheads, G., French, J., Ikin, P. (1991). Welfare and veterinary care of donkeys. *In Pract.* 13, 62–68.  
<https://doi.org/10.1136/inpract.13.2.62>
16. D'Alessandro, A.G., Martemucci, G. (2007). Influence of milking number and frequency on milk production in Martina Franca breed asses. *Ital J Anim Sci.* 6 (Suppl. 1): 643–645.
17. D'Alessandro, A.G., De Petro, R., Claps, S., Pizzillo, M., Martemucci, G. (2009). Yield and quality of milk and udder health in Martina Franca ass: Effects of daily interval and time of machine milking. *Ital J Anim Sci.* 8 (Suppl. 2): 697–699.  
<https://doi.org/10.4081/ijas.2009.s2.697>
18. French, J.M. (1998). Mother-offspring relationships in donkeys. *Appl Anim Behav Sci.* 60, 253–258.  
[https://doi.org/10.1016/S0168-1591\(98\)00173-7](https://doi.org/10.1016/S0168-1591(98)00173-7)
19. Trawford, A.F., Mulugeta, G. (2008). Parasites. *In: E.D. Svendsen, J. Duncan, D. Hadrill (Eds). The professional handbook of the donkey, 4th ed (pp. 82–110). Yatesbury, Wiltshire, UK: Whittet Books.*
20. Svendsen, E.D. (2009). *The complete book of the donkey*. Kenilworth Press.
21. Martin Curran, M., Feseha, G., Smith, D. (2005). The impact of access to animal health services on donkey health and livelihoods in Ethiopia. *Trop Anim Health Prod.* 37 (Suppl. 1): 47–65.  
<https://doi.org/10.1007/s11250-005-9008-z>  
PMid:16335071
22. Dai, F., Segati, G., Dalla Costa, E., Burden, F., Judge, A., Canali, E., Minero, M. (2017). Ensuring welfare on farm of donkeys kept for milk production: an analysis of the legislation. *Large Anim Rev.* In press.
23. Dai, F., Segati, G., Burden, F., Judge, A., Minero, M. (2016). Ensuring welfare of donkeys kept for milk production: a review of the legislation. *In: S. Heat, S. McCulloch, D. Jacinto, G. da Graça Pereira (Eds.). European Congress Animal Welfare & Behaviour Medicine (p. 105). Cascais, Portugal: PsiAnimal.*
24. Giacometti, F., Bardasi, L., Merialdi, G., Morbarigazzi, M., Federici, S., Piva, S., Serraino, A. (2016). Shelf life of donkey milk subjected to different treatment and storage conditions. *J Dairy Sci.* 99 (6): 4291–4299.  
<https://doi.org/10.3168/jds.2015-10741>  
PMid:26995124
25. Sarno, E., Santoro, A.M.L., Di Palo, R., Costanzo, N. (2012). Microbiological quality of raw donkey milk from Campania region. *Ital J Anim Sci.* 11 (3): 266–269.  
<https://doi.org/10.4081/ijas.2012.e49>
26. Altieri, G., Di Renzo, C.G., Genovese, F. (2008). Preliminary results using a new method to optimize a spray dryer process for producing high quality milk powder from cow, goat and she-ass milk concentrates. *J. of Ag. Eng.* 4, 35-41.