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Short communication: Monitoring nutritional quality of Amiata donkey milk: Effects of lactation and productive season

Mina Martini,*[1] Iolanda Altomonte,† Federica Salari,† and Anna M. Caroli‡
*Dipartimento di Scienze Veterinarie, Università di Pisa, Pisa, 56100 Italy
†Centro di Ricerche Agro-Ambientali Enrico Avanzi, San Piero a Grado, Pisa, 56122 Italy
‡Dipartimento di Medicina Molecolare e Translazionale, Università degli Studi di Brescia, Brescia, 25123 Italy

ABSTRACT

Milk nutritional characteristics are especially interesting when donkey milk is aimed at consumption by children and the elderly. The aim of this study was to monitor the nutritional quality of Amiata donkey milk during lactation and productive season to provide information on the milk characteristics and to study action plans to improve milk yield and quality. Thirty-one pluriparous jennies belonging to the same farm were selected. Individual samples of milk from the morning milking were taken once per month starting from the d 30 of lactation until d 300. Milk yield and dry matter, fat, and ash content were constant throughout the experimental period. Milk total protein content showed a progressive decrease during the first 6 mo of lactation; after this period, the protein percentages remained constant (1.50%). Caseins and lactose were lower until d 60 of lactation and remained constant thereafter. During summer and autumn, milk yield and casein and lactose contents were higher, whereas during the spring season, higher protein and ash contents were found. The percentages of fat and dry matter were stable as were most of the minerals in the milk, except for calcium, which was higher in the spring. In conclusion, Amiata donkey milk was found to be relatively stable during lactation. This is an advantage in terms of the production and trade of a food product with consistent characteristics. The different milk yield and quality during the productive seasons were probably related to better adaptability of the animals to warm and temperate periods.
Key words: Amiata donkey milk, nutritional quality, lactation, season

Short Communication

Despite the small-scale production, donkey milk (**DoM**) has recently been of particular interest in the scientific and husbandry fields (Martini et al., 2014a,b). In fact, clinical studies have shown that it is an effective treatment for allergies to cow milk proteins or in cases of multiple food intolerance (Monti et al., 2007).

In addition, DoM has beneficial effects in terms of the energy balance, lipid metabolism, prevention of diseases (Jirillo et al., 2010; Lionetti et al., 2012), and it is considered as a "functional food" (Ivanković et al., 2009). Given the quality of DoM, rearing this adaptable and low-maintenance-cost species could be a source of income for many marginal areas and help safeguard endangered breeds.

In central Italy, a native donkey breed, Amiata (or Amiatino), is reared. The name is derived from the traditional farming area of Mount Amiata (Tuscany, Italy). The population was once reared as working animals, but agricultural industrialization brought the population near to extinction. Only recently have measures to safeguard the population been introduced, and the Amiata donkey is now used for donkey rides, pet therapy, and also for milk production. Recently, a project in Tuscany has created a DoM chain for human consumption, and also focused milk production on cosmetics and probiotics.

Milk production varies depending on genetic, environmental, and physiological factors. However, cow milk is mostly standardized, whereas DoM has high variability in terms of its components (Claeys et al., 2014). In addition, variations in the quality of DoM as a result of physiological factors, such as the distance from delivery, have been poorly studied and little is known about the changes that occur in the quality of Amiata DoM during lactation. We evaluated the quality of Amiata DoM, focusing on the physiological stage of lactation and on the season to better understand milk characteristics and to study action plans to improve milk yields and quality.

Thirty-one pluriparous (9 ± 2 yr old) Amiata jennies belonging to the same farm were selected. The jennies were raised outdoors in a free animal-housing system with an indoor rest area. The animals had a BCS of 4.9 (Pearson and Ouassat, 2000) and were fed ad libitum

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[1]Corresponding author: mina.martini@unipi.it

mixed grass hay and about 2.5 kg/d per head of commercial pelleted concentrate (Progeo Società Cooperativa Agricola, Reggio Emilia, Italy) for dairy jennies.

Animals had free access to clean and fresh water. The jennies were routinely machine milked by a wheeled trolley milking machine (DeLaval S.p.A., San Donato Milanese, Italy). Foals were separated from the dams 3 to 3.5 h before the first milking according to Salimei et al. (2004). Individual samples of milk from the morning milking were taken once per month starting from d 30 of lactation until d 300.

Milk samples were taken to the laboratory in tanks at 4°C. The following parameters were evaluated on fresh DoM samples: DM, fat, and lactose contents by infrared analysis (MilkoScan; Italian Foss Electric, Padova, Italy), and proteins, caseins, ash, Ca, P, K, Na, Mg, and Zn, using methods of the Association of Official Analytical Chemists (AOAC, 1990). The results of the milk composition were analyzed using ANOVA for repeated measurements, considering the sampling time and the production season as fixed effects and the subject as a random effect. Least significance means were compared by *t*-test. Significant differences were considered at $P < 0.01$. Statistical analysis was carried out using JMP software (SAS Institute, 2002).

Table 1 shows the changes in the composition of the Amiata DoM during lactation. The milk yield was constant throughout the experimental period, showing only a slight and not significant increase between d 60 and 90 after delivery. In Martina Franca (Salimei and Fantuz, 2012) and Ragusano jennies (Bordonaro et al., 2013) the average milk yield has been determined to decline during lactation and to subsequently stabilize up to mo 8 to 10 of lactation.

Although a comparison with cow milk goes beyond the aim of the present study, it can be pointed out that DM, fat, proteins, casein, and ash contents were lower in DoM compared with cow milk, whereas lactose content was higher (Barłowska et al., 2011; Cosentino et al., 2012). Furthermore, DoM was for some parameters more similar to human than cow milk.

As observed in the donkeys of Southern Italy, Amiata donkey DM and fat content also did not undergo significant changes during lactation. However, fat content in Amiata jennies showed an intermediate range (0.30–0.44%) between the range reported for Martina Franca (0.42–0.72%) and Ragusano jennies (0.11–0.19%) during lactation (Salimei et al., 2004; Cosentino et al., 2012; Martemucci and D'Alessandro, 2012; Bordonaro et al., 2013). These differences may be due to the origin of the breed.

In the first 6 mo of lactation, we found a progressive and significant decrease in the protein content ($P < 0.01$); after this period the protein percentage was

Table 1. Effect of the lactation stage on donkey milk yield and quality

	DIM										
Item	30	60	90	120	150	180	210	240	270	300	SEM
Morning milk yield, mL	306.75	379.08	375.36	319.52	349.75	285.63	259.78	256.54	278.55	261.92	127.918
DM, %	9.76	9.25	9.36	9.45	9.41	9.64	9.67	9.51	10.06	10.01	0.446
Fat, %	0.42	0.35	0.34	0.42	0.43	0.41	0.44	0.46	0.44	0.35	0.301
Protein, %	1.77^{a}	1.61^{b}	1.57^{c}	1.58^{c}	1.56^{c}	1.53^{d}	1.53^{d}	1.54^{d}	1.50^{d}	1.51^{d}	0.099
Casein, %	0.56^{b}	0.65^{b}	0.75^{a}	0.79^{a}	0.78^{a}	0.82^{a}	0.75^{a}	0.77^{a}	0.73^{a}	0.78^{a}	0.188
Lactose, %	6.85^{b}	7.09^{b}	7.25^{ab}	7.20^{ab}	7.20^{ab}	7.29^{a}	7.18^{ab}	7.22^{ab}	7.20^{ab}	7.21^{ab}	0.185
Ash, %	0.48^{a}	0.40^{b}	0.35^{bc}	0.36^{bc}	0.35^{bc}	0.34^{c}	0.33^{c}	0.37^{bc}	0.35^{bc}	0.36^{bc}	0.053
Ca, %	0.13	0.13	0.15	0.10	0.11	0.091	0.12	0.09	0.11	0.10	0.026
P, %	0.10	0.06	0.08	0.07	0.07	0.06	0.07	0.07	0.06	0.07	0.011
K, %	0.09	0.06	0.08	0.08	0.07	0.05	0.07	0.08	0.06	0.11	0.022
Na, %	0.02	0.02	0.02	0.03	0.02	0.01	0.02	0.01	0.01	0.03	0.005
Mg, %	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.007
Zn, mg/kg	0.70	0.66	0.54	0.58	0.68	0.50	0.65	0.51	0.72	0.70	0.168

[a-c]Within a row, means without a common superscript differ at $P < 0.01$.