

PRODUCTION OF DONKEY MILK FOR HUMAN FEEDING: CHANGES OF GROSS COMPOSITION AND ENERGETIC VALUE DURING LACTATION IN MARTINA FRANCA BREED

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Composition characteristics and energetic value of donkey milk were investigated during the lactation in Martina Franca breed, an autochthonous breed of Southern Italy. Individual milk samples were collected once a month from nine adult healthy asses, daily milked by machine milking from the 1st to the 8th month after foaling. Milk was analyzed to determine composition in macro-nutritional parameters (fat, protein, lactose), casein, fat-free dry matter (FDM), urea, pH and to calculate gross energy values. Results showed that the lactation stage of asses influences protein and FDM ($P < 0.01$) and casein contents ($P < 0.05$). Overall, protein, FDM, casein as well as fat contents of milk showed the highest values at the first month of lactation (1.86, 9.26, 1.54, 0.71 % respectively), a gradual decreasing trend throughout the lactation, which became significant ($0.05 > P < 0.01$) from the 6th–7th month. The gross energetic values follow the same trend, with the highest value at the 1st month of lactation ($1831.53 \text{ kJ}\cdot\text{kg}^{-1}$) and a marked reduction in correspondence to the 7th–8th month (–10%). Constant ($P > 0.05$) during lactation resulted the values of lactose (6.52 to 6.76 %), urea (34.10 to 35.62 mg/dl) and pH (6.87 to 6.93). These findings give a basic knowledge on the nutritional characteristics of Martina Franca donkey milk which is important for its employ in human feeding.

Key words: donkey; milk; composition; energetic value

ПРОИЗВОДСТВО НА МАГАРЕШКО МЛЕКО ЗА ЧОВЕЧКА ИСХРАНА: ПРОМЕНИ ВО БРУТО СОСТАВОТ И ЕНЕРГЕТСКАТА ВРЕДНОСТ ЗА ВРЕМЕ НА ЛАКТАЦИЈА КАЈ РАСАТА MARTINA FRANCA

Истражувани се составот и енергетската вредност на магарешко млеко во текот на лактација кај расата Martina Franca, автохтона раса во јужна Италија. Еднаш месечно беа собирани поединечни примероци на млеко од 9 возрасни здрави магарници молзени со помош на машина за молзење, во периодот од 1-иот до 8-иот месец по партусот. Млекото беше анализирано за да се одреди составот во однос на макронутриционистичките параметри (масти, протеини, лактоза), казеин, обезмастена сува материја (ОСМ), уреа, рН и беше пресметана бруто-енергетската вредност. Утврдено е дека лактациската фаза влијае врз содржината на протеини и обезмастена сува материја ($P < 0,01$), како и врз содржината на казеин во млекото ($P < 0,05$). Вкупната содржина на протеини, обезмастена сува материја, казеин, како и содржината на маст во млекото, беше највисока во првиот месец на лактацијата (1.86; 9,26; 1,54 и 0,71 %, соодветно), а потоа постоеше тренд на постепено намалување во текот на лактацијата, кое стана значајно ($0,05 > P < 0,01$) од 6-тиот до 7-иот месец. Бруто-енергетските вредности го следеа истиот тренд со највисока вредност во првиот месец на лактацијата ($1831,53 \text{ kJ}\cdot\text{kg}^{-1}$) и со значително намалување во однос на 7–8-иот месец (–10%). Константата ($P > 0,05$) за време на лактацијата резултираше со вредностите на лактозата од 6,52 до 6,76 %, уреа од 34,10 до 35.62 mg/dl и рН од 6,87 до 6,93. Овие заклучоци даваат основни познавања за нутриционистичките карактеристики на магарешко млеко од расата Martina Franca кое е од значење за користење во човечката исхрана.

Клучни зборови: магаре; млеко; состав; енергетска вредност

1. INTRODUCTION

In the last years, great interest has been developed toward donkey milk for human feeding, because of its high likeness to human milk (Carroccio et al., 2000) and nutraceutical effects (Tafaro et al., 2007). Moreover, it has been suggested as possible substitute to cow's milk in feeding of children affected by cow's milk proteins allergy (Iacono et al., 1992; Carroccio et al., 2000; Monti et al., 2007; Tesse et al., 2008). In terms of production of donkey milk for human nutritional purposes, it is important to define how milk composition and the energetic value change in response to different factors. In mares, it has been reported that milk production and composition may change in relation to the lactational stage, age, parity and nutrition (Doreau et al., 1992; Csapò et al., 1995).

The study aims to investigate the gross composition and its changes during lactation, and to establish the energetic value of donkey milk in Martina Franca breed, for its employ in human feeding.

2. MATERIAL AND METHODS

The study was carried out for a whole lactation (8 months) on nine healthy adult asses of the Martina Franca breed, reared under semi-extensive conditions, in the typical breeding area for this breed (South-Eastern Murgia, Apulia region, Southern Italy). The animals were milked twice a day in the presence of foals, by machine. Individual milk samples were collected once a month for the analysis of gross composition (fat, protein, lactose; FIL-IDF 141 C:2000; Milkoscan 6000), casein, fat-free dry matter (FDM), urea and pH. The energetic value was calculated (Perrin, 1958). Data were statistically analyzed by the SAS GLM procedure (SAS, 2000) with means compared by Student's *t* test.

3. RESULTS AND DISCUSSION

The lactation stage of asses influences protein and FDM ($P < 0.01$) and casein contents ($P < 0.05$). The macro-nutritional means values (fat, protein, lactose) are reported in Table 1. Overall, fat and protein contents of milk showed the highest values at the first month of lactation (0.71%,

1.86%, respectively), a gradual decreasing trend throughout the lactation period, which became significant ($0.05 > P < 0.01$) from the 6th–7th month. The lactose content remains constant during the eight months of lactation (range: 6.52 to 6.76%; $P > 0.05$).

Our results in fat contents showed a trend similar to that found by Alabiso et al. (2005) in the Ragusana donkeys, another Italian breed, but substantially different compared to those reported by Salimei et al. (2004) and Guo et al. (2007; Jiangyue breed).

The results of protein contents of this study are in agreement with those found in other studies (Salimei et al., 2004; Alabiso et al., 2005; Guo et al., 2007).

Table 1

*Gross composition during lactation
(% (w/w); mean values \pm SD)*

Month of lactation	Fat (%)	Protein (%)	Lactose (%)
1 st	0.71 \pm 0.10 ^a	1.86 \pm 0.19 ^A	6.68 \pm 0.26
2 nd	0.65 \pm 0.15	1.72 \pm 0.07 ^{ABa}	6.72 \pm 0.11
3 rd	0.54 \pm 0.15	1.75 \pm 0.18 ^A	6.74 \pm 0.34
4 th	0.55 \pm 0.17	1.78 \pm 0.22 ^A	6.76 \pm 0.08
5 th	0.50 \pm 0.22	1.72 \pm 0.16 ^A	6.52 \pm 0.27
6 th	0.48 \pm 0.06	1.62 \pm 0.05 ^{bc}	6.58 \pm 0.10
7 th	0.42 \pm 0.33 ^b	1.58 \pm 0.20 ^{Bc}	6.64 \pm 0.15
8 th	0.50 \pm 0.35	1.40 \pm 0.20 ^C	6.66 \pm 0.07

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

The gross energetic values of milk follow a decreasing trend, with the highest value at the 1st month of lactation (1831.53 kJ·kg⁻¹) and a marked reduction in correspondence to the 7th–8th month (–10%) (Table 2). On average, the energetic value of milk in this study (1719.24 kJ·kg⁻¹) corresponds to that reported by Salimei et al. (2004).

Among the other physico-chemical parameters of milk, lactation stage influences FDM ($P < 0.01$) and casein contents ($P < 0.05$) which showed the same decreasing trend from the first to the 7th–8th month ($0.05 > P < 0.01$) (Table 3). On average, casein was 1.6 times higher compared to that reported by Salimei et al. (2004). No significant variations ($P > 0.05$) resulted for the urea contents

(range: 34.10 to 35.62 mg/dl) and pH values (6.87 to 6.93; Table 3).

Table 2

Energetic values of donkey milk during lactation

Month of lactation	Gross energy (kJ·kg ⁻¹)	Loss of gross energy (%)
1 st	1831.53	
2 nd	1780.92	- 2.76
3 rd	1749.64	- 4.47
4 th	1764.12	- 3.68
5 th	1690.65	- 7.69
6 th	1668.41	- 8.91
7 th	1645.64	- 10.15
8 th	1635.30	- 10.71

Table 3

Casein, urea, fat-free dry matter (FDM) contents (%; w/w) and pH values of donkey milk during lactation (mean values ± SD)

Month of lactation	Casein (%)	FDM (%)	Urea (mg/dl)	pH
1 st	1.54 ± 0.17 ^A	9.26 ± 0.31 ^A	35.62 ± 7.24	6.87 ± 0.06
2 nd	1.45 ± 0.03 ^{AB}	9.11 ± 0.10	35.60 ± 2.03	6.89 ± 0.03
3 rd	1.46 ± 0.08 ^{ABa}	9.13 ± 0.16 ^a	33.20 ± 2.50	6.87 ± 0.05
4 th	1.46 ± 0.24 ^{AB}	9.31 ± 0.09 ^A	33.59 ± 1.30	6.93 ± 0.02
5 th	1.49 ± 0.09 ^A	9.11 ± 0.11 ^{ab}	35.06 ± 4.22	6.89 ± 0.03
6 th	1.38 ± 0.04	8.90 ± 0.14 ^B	34.10 ± 1.06	6.87 ± 0.02
7 th	1.34 ± 0.20 ^{Bb}	8.96 ± 0.21 ^{Bb}	33.71 ± 4.22	6.87 ± 0.06
8 th	1.17 ± 0.18 ^C	8.82 ± 0.21 ^{Bc}	34.10 ± 3.09	6.87 ± 0.05

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

4. CONCLUSIONS

Data from this study are an important reference for an in-depth knowledge of donkey milk and in particular for the Martina Franca breed. The values of compositional parameters resulted from the current study can be used as a valuable aid to optimize the use of donkey milk for human feeding. Further studies should be carried out in order to improve its energetic value so that it can satisfy energetic requirement of baby consumers.

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REFERENCES

- Alabiso M., Russo G., Giosuè C., Alicata M. L., Torrisi C., La produzione di latte nell’arco di una intera lattazione in asine allevate in Sicilia. In: *Proc. 7° Conv. Nuove acquisizioni in materia di ippologia*, Lodi, 22–23 giugno, 153–160 (2005).
- Carroccio A., Cavataio F., Montalto G., D’Amico D., Alabrese L., Iacono G., Intolerance to hydrolyzed cow’s milk proteins in infants: clinical characteristics and dietary treatment. *Clin. Exp. All.*, 30, 1597–1603 (2000).
- Csapò J., Stefler J., Martin T. G., Makray S., Csapò-Kiss Z. S., Composition of mares’ colostrum and milk. Protein content, amino acid and contents of macro- and microelements. *Int. Dairy J.*, 5, 403–415 (1995).
- Doreau M., Boulot D., Bauchart D., Barlet J. P., Martin-Rosset W., Voluntary intake, milk production and plasma metabolites in nursing mares fed two different diets. *J. Nutr.*, 122 (4), 992–999 (1992).
- Guo H. Y., Pang K., Zhang X. Y., Zhao L., Chen S. W., Dong M. L., Ren F. Z., Composition, physicochemical properties, nitrogen fraction distribution, and amino acid profile of donkey milk. *J. Dairy Sci.*, 90, 1635–1543 (2007).
- Iacono G., Carroccio A., Cavataio F., Montalto G., Soresi M., Balsamo V., Use of ass’s milk in multiple food allergy. *J. Pediatr. Gastroenterol. Nutr.*, 14 (2), 177–181 (1992).
- Monti G., Bertino E., Muratore M. C., Coscia A., Cresi F., Silvestro L., Fabris C., Fortunato D., Giuffrida M. G., Conti A., 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, 259–264 (2007).
- Perrin D. R., The caloric value of milk of different species. *J. Dairy Sci.*, 25, 215–220 (1958).
- Salimei E., Fantuz F., Coppola R., Chiofalo B., Polidori P., Varisco G., Composition and characteristics of ass’s milk. *Anim. Res.*, 53, 67–78 (2004).
- SAS, *User’s Guide Statistics*. Version 8.2. SAS Institute, Inc. Cary, NC, USA (2000).
- Tafaro A., Magrone T., Jirillo F., Martemucci G., D’Alessandro A. G., Amati L., Jirillo E., Immunological properties of donkey’s milk: its potential use in the prevention of atherosclerosis. *Current Pharmaceutical Design*, 13, 1–7 (2007).
- Tesse R., D’Alessandro A. G., Pagliarunga C., Rizzi D., Bozza S., Martemucci G., Armenio L., Does donkey’s milk may represent an alternative dietary support in patients with cow’s milk induced IgE mediated and non-IgE-mediated disorders? Case reports. *Proc. XXVII Congress of the European Academy of Allergology and Clinical Immunology*, Barcelona, Spain, 7–11 June 2008 (2008).