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Characteristics of the lactation, chemical composition and milk hygiene quality of the Littoral-Dinaric ass

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Summary

Milk production is one of the possible economic uses of donkey population. The Littoral-Dinaric donkey is numerous, but the structural changes in rural areas during the last decade have pushed it into a group of endangered genetic heritage. The aim of this research is to determine the production potential, lactation characteristics, chemical composition and hygienic quality of the Littoral-Dinaric ass milk. The average milk production was 172.12 mL per milking with the average fat percentage of 0.33 %, milk protein 1.55 %, and lactose 6.28 %. The low average number of somatic cells and bacterial count are noticed in ass's milk (4.09 mL log^{-1}; 3.58 mL log^{-1}). A significant influence of lactation stage on the milk quantity and proportion of dry matter ($P<0.01$), as well on the proportion of milk fat and milk protein ($P<0.05$), was observed. Also the influence of the season on productivity, and the proportion of dry matter and milk fat ($P<0001$), as well as milk protein ($P<0.01$) was also significant. Productivity of the Littoral-Dinaric ass in the pasture system is relatively modest, but the direct and indirect benefits from this kind of production are multiple. That is the reason to continue the development of donkey milk production technology.

Key words: milk ass, productivity, chemical composition, hygienic quality

Introduction

In the developed economies, donkeys have lost their fundamental work function, which makes them a vulnerable species in terms of sustainability. Like other developed EU countries, Croatia maintains its donkey population by supporting it with various promotion measures, and the program of economic activation is of special interest in such a support. One of the economic programs which attract considerable attention is production of ass's milk. In production technology and production parameters, there are many doubts, particularly in terms of quantity and chemical composition of milk. In addition, changes occur during lactation in these production parameters, partly due to genetic and non-genetic factors.

Ass's milk composition and its organoleptic characteristics are similar to human milk, especially in regard to the composition of proteins and lipids. It contains low amounts of casein and β-lactoglobulin, and high concentrations of lysozyme, essential to protect digestive system of children from various infections (Fantuz et al., 2001). The level of β-lactoglobulin as potential allergen component in ass's milk is the same as, or lower than in mare's milk (Matrtuzzi et al., 2000; Doreau et al., 2002;

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Malacarne et al., 2002), and significantly lower compared to bovine milk (Solaroli et al., 1993), which makes it more suitable in nutrition of people intolerant to cow milk (Carroccio et al., 2000; Monti et al., 2007). Ass's milk compared to the milk of other species has the most intense inhibitor potential to bacteria due to the significant content of antimicrobial substances (Zhang et al., 2008). Of special interest is the fact that lysozym concentration in ass's milk reaches the level of 4000 mg/L, whereas in *bovine* milk it appears in traces (Salimei et al., 2004; Guo et al., 2007).

In the last decade, ass's milk has attracted considerable scientific interest in Europe, primarily because of its nutritional and functional ingredients. It presents suitable milk substitute for the infants to whom human milk is inaccessible, or in cases where during the first months of life infants show allergic reactions to cow's milk (Iacono et al., 1992). Clinical studies confirm that feeding with ass's milk is the best and safest treatment at complicated cases of multiple food intolerance (Carroccio et al., 2000; Monti et al., 2007). Dell'Orto et al. (1993) identified a positive effect in ass's milk in hypo-cholesterols diet. Wolter (1996) highlights the positive effect of milk during osteogenesis, treatment of atherosclerosis, and rehabilitation of patients with heart problems and diseases. Pinto and Sportelli (1998) emphasize the positive effects of ass's milk in the prevention of aging. Significant presence of unsaturated fatty acids is important in the prevention of cardiovascular, autoimmune and inflammatory diseases (Chiofalo and Salimei, 2001). The mentioned characters indicate that the ass's milk can be considered as ''functional food'' (Williams, 2000).

In the Mediterranean part of Croatia, donkeys have been used for centuries mostly as working animals, suitable for breeding because of their modesty, strength and endurance. Structural changes in the rural Mediterranean part of Croatia during the last decade have led to a significant decline in the number of donkeys. The total population of donkeys in Croatia is estimated at four thousand, of which a small part is upgraded. The Littoral-Dinaric donkey is the most represented in Croatia (~80 %), but due to its low reproductive activity and negative population trends, it belongs to a group of highly endangered breeds (Ivanković et al., 2000). Today, except for work, donkeys are used in riding, oniotherapy, tourism, and meat and milk production. In former times, ass's milk was rarely used as food, mainly as means for strengthening the immune system and in traditional treatment of certain diseases, especially the respiratory system. With the aim of finding an effective model of economic affirmation of donkeys, production of ass milk is very noticeable.

The aim of the research is to determine the influence of the lactation stage and seasons on the production potential, lactation characteristics, chemical composition and hygienic quality of the Littoral-Dinaric ass's milk. The knowledge about the chemical composition and hygiene quality of the milk should initiate its production and use under the label of the biologically healthy functional food. Acceptance of ass's milk from markets can improve income, reproductive efficiency and sustainability of indigenous Littoral-Dinaric ass.

Materials and methods

The study included fourteen asses of the Littoral-Dinaric breed from the County of Zadar. Lactation production parameters were monitored during the 150 days of lactation, in the period from May to October 2007. Nutrition was based solely on grazing and hay addition. The first milking control was performed 20±5 days after parturition, and then in the interval of 20 days. Asses were milked once, in the morning period (at 9.00 a.m.), manually. During the preparation of, and the milking process itself (3 hours prior to milking and immediately after milking), foals were physically separated from their mother, but left within the visual contact. After milking, the amount of milk was measured and the samples collected for further analysis were placed in bottles with preservatives and stored at 4 ºC until the chemical and hygiene analysis in the reference laboratory of the Dairy Science Department, Faculty of Agriculture in Zagreb.

The respective shares of dry matter (DM), milk fat (F), and milk protein (P) were determined by the method of infrared spectrometry by Milkoscan FT120, followed by working instructions HRN ISO 9622:2001. Milkoscan FT120 was calibrated on the basis of ten standardized samples with known values for each parameter. In standardized samples, the fraction of dry matter was determined by drying

in accordance to the HRN ISO 6731:1999, milk fat fraction according to the HRN ISO 1211:2001, and lactose (L) according to the HRN ISO 5765-1:2003 norm. The number of somatic cells (SSC) was determined by the fluoro-opto-electronic method on Fossomatic 90, according to the HRN ISO 13366-2:2007 norm. The total number of bacteria (BCC) was determined by the flow cytometric method on Bactoscan FC, according to the ISO 21187:2004 norm. A Bactoscan FC apparatus was calibrated on the basis of the numbers of colonies, which were determined by reference method (counting the colonies of bacteria at 30 °C), according to the HRN ISO 4833:2003 norm.

The results were processed using the GLM procedures of the SAS statistical package (SAS Institute, 1999). Influence of lactation stage (SL) and season on the productivity, chemical composition and hygienic quality of milk was analyzed by using ANOVA linear models. Lactation stage was divided into seven classes: SL I (15 to 35 day), SL II (36 to 55 day), SL III (56 to 75 day), SL IV (76 to 95 day), SL V (96 to 115 day), SL VI (116 to 135 day) and SL VII (136 to 155 day). Considering the influence of the season on indicators of lactations, the monitored period was divided into three intervals: spring (from May to June), summer (from July to August) and autumn (from September to October).

Results and discussion

The average ass's milk yield during the lactation was 172 mL per milking. The milk production of the Littoral-Dinaric asses was lower than the production of some earlier investigated breeds, respectively. Chiofalo and Salimei (2001) reported 0.77 kg milk per milking for Ragusana asses, while Alabiso et al. (2008), for the same breed, reported a lower production (0.55-0.70 kg per milking). Salimei et al. (2005) reported for the Martina Franca ass breed a production from 0.61 to 0.76 kg milk per milking. Difference in milk yield can be due to the absence of concentrate in the Littoral-Dinaric asses' diet, while the basic diet of the Ragusana and Martina Franca asses was supplemented with 2.5 kg to 3 kg of concentrate per day. In the analyzed Littoral-Dinaric asses group, milk yield was significantly influenced ($P<0.01$) by the individual, while the other parameters (dry matter, milk fat, milk protein, lactose, somatic cell count, bacterial cell count) were not significantly influenced by the individual. The chemical composition and hygienic quality of the asses' milk are presented in Table 1.

The observed average dry matter content (8.80 %) was consistent with the data for dry matter content (8.84 %) reported by Salimei et al. (2004). The observed average milk fat content (0.33 %) was found to be lower than values reported by Chio-

Table 1: Chemical composition and hygienic parameters of Littoral-Dinaric asses' milk
Tablica 1: Kemijski sastav i higijenska kvaliteta mlijeka magarica primorsko-dinarske pasmine

	$\bar{x}$ Prosjek	SE	SD	MIN.	MAX.
Milk yield per milking (mL/milking) Količina mlijeka po mužnji (mL/mužnji)	172.12	3.034	26.79	120	230
Dry matter (%)/Suha tvar (%)	8.80	0.044	0.38	7.92	9.82
Fat (%)/Mliječna mast (%)	0.33	0.021	0.18	0.12	0.96
Protein (%)/Bjelančevine (%)	1.55	0.028	0.25	1.03	2.16
Lactose (%)/Laktoza (%)	6.28	0.029	0.25	5.61	6.97
SCC ($\log_{10}$ mL^{-1}) Broj somatskih stanica ($\log_{10}$ mL^{-1})	4.09	0.057	0.46	3.00	4.94
BCC ($\log_{10}$ mL^{-1}) Broj mikroorganizama ($\log_{10}$ mL^{-1})	3.58	0.041	0.34	3.00	4.26

falo and Salimei (2001), Salimei et al. (2004), Giosuè et al. (2008) and Piccione et al. (2008). Giosuè et al. (2008) reported the influence of the season on the milk fat content. The milk of asses foaled in spring had 0.28 % of milk fat, while the milk of those foaled in autumn had 0.52 % of milk fat. The milk fat content range (0.12 % to 0.96 %) was found to be lower than reported by Salimei et al. (2004), Guo et al. (2007) and Giosuè et al. (2008).

The observed average milk protein content (1.56 %) was lower (1.72 %, 1.89 %) than reported by Salimei et al. (2004) and Giosuè et al. (2008). The milk protein content range (1.03 % to 2.16 %) was wider (1.25 % to 2.18 %) than reported by Salimei et al. (2004). The average lactose content in the Littoral-Dinaric asses' milk (6.28 %) was found to be lower than reported in the earlier researches (Chiofalo et al., 2004; Salimei et al., 2004; Alabiso et al., 2008; Giosue et al., 2008). Giosue et al. (2008) found lower lactose content in the milk of the asses foaled in spring (6.2 %) than in the milk of those foaled during summer and winter (6.3 % to 6.6 %).

The average somatic (4.09 $\log_{10}$ mL^{-1}) and bacterial cell count (3.58 $\log_{10}$ mL^{-1}) in asinine milk was found to be lower than usual average of SCC and BCC in sheep, goats and cows milk resulting from strong inhibitory potential on microorganisms (Zhang et al., 2008). In comparison to earlier researches (Salimei et al., 2004; Alabiso et al., 2008; Giosue et al., 2008; Piccione et al., 2008), the milk of the Littoral-Dinaric asses had a slightly higher BCC. In comparison to the research results (Salimei et al., 2004) for Ragusana and Martina Franca breeds, the Littoral-Dinaric asses' milk had a lower SCC. Table 2 presents the effect of the lactation stage on the yield and composition of asinine milk.

The lactation period significantly affected milk yield and dry matter content ($p<0.01$), while the effect on fat content and protein was less significant ($p<0.05$). The research did not show a significant effect of the lactation period on the lactose content,

Table 2: Change of yield and composition of asinine milk during lactation
Tablica 2: Promjene količine i sastava mlijeka magarica tijekom laktacije

	SL I	SL II	SL III	SL IV	SL V	SL VI	SL VII	Significance level Stupanj značajnosti
Milk yield (mL/per milking) Količina mlijeka po mužnji (mL/mužnji)	188.6	185.0	180.7	174.2	163.4	163.2	148.3	**
Dry matter (%)/Suha tvar (%)	9.13	9.12	8.83	8.67	8.63	8.61	8.62	**
Fat (%)/Mliječna mast (%)	0.45	0.41	0.32	0.32	0.30	0.22	0.22	*
Protein (%)/Bjelančevine (%)	1.77	1.66	1.49	1.48	1.51	1.52	1.41	*
Lactose (%)/Laktoza (%)	6.23	6.38	6.37	6.19	6.24	6.25	6.29	ns
SCC ($\log_{10}$ mL^{-1}) Broj somatskih stanica ($\log_{10}$ mL^{-1})	4.34	4.22	4.05	4.05	3.86	3.94	3.98	ns
BCC ($\log_{10}$ mL^{-1}) Broj mikroorganizama ($\log_{10}$ mL^{-1})	3.81	3.64	3.57	3.64	3.42	3.56	3.36	ns

**P<0.01; *P<0.05; ns - not significant/nije signifikantno

Table 3: Changes of yield and composition of asinine milk during seasons
Tablica 3: Promjene količina i sastava mlijeka magarica tijekom sezona

	Spring Proljeće	Summer Ljeto	Autumn Jesen	Significance level Stupanj značajnosti
Milk yield (mL/ milking) Količina mlijeka po mužnji (mL/mužnji)	189.2	175.8	153.6	***
Dry matter (%)/Suha tvar (%)	9.15	8.66	8.63	***
Fat (%)/Mliječna mast (%)	0.49	0.22	0.29	***
Protein (%)/Bjelančevine (%)	1.65	1.43	1.57	**
Lactose (%)/Laktoza (%)	6.31	6.29	6.19	ns
SCC (log_{10} mL^{-1}) Broj somatskih stanica (log_{10} mL^{-1})	4.13	3.94	4.08	ns
BCC (log_{10} mL^{-1}) Broj mikroorganizama (log_{10} mL^{-1})	3.59	3.47	3.58	ns

***P<0.001; **P<0.01; ns - not significant/nije signifikantno

Table 4: Correlation coefficients of asinine milk composition components
Tablica 4: Koeficijenti korelacija komponenti mlijeka magarice

	Dry matter Suha tvar	Milk fat Mliječna mast	Proteins Bjelančevine	Lactose Laktoza	SCC Broj somatskih stanica	BCC Broj mikroorganizama
Milk yield/Proizvodnja mlijeka	0.340**	0.410**	- 0.027	0.203	0.197	0.014
Dry matter/Suha tvar		0.650**	0.534**	0.310**	0.318**	0.408**
Fat/Mliječna mast			0.368**	- 0.134	0.497**	0.481**
Protein/Bjelančevine				- 0.416**	0.368**	0.393**
Lactose/Laktoza					- 0.213	- 0.293*
SCC/Broj somatskih stanica						0.316**

**P<0.01; *P<0.05

SCC and BCC in ass's milk (Table 2). Milk yield was the highest in the first lactation stage (SL I) and had a negative trend throughout lactation that is consistent with the results reported by Giosué et al. (2004). Contrary to these results, Salimei et al. (2004) did not report a negative trend in milk yield throughout lactation. During lactation, the milk fat content significantly decreased, which is consistent with the results of the Malacarnei et al. (2002) and Giosué et al. (2008) researches. The highest milk protein content (1.77 %) was found at the start of lactation and the lowest (1.41 %) at end of lactation. The same trend of milk protein content during lactation in asinine milk was reported in the earlier researches (Salimei et al., 2004; Guo et al., 2007; Giosué et al., 2008). The lactation stage did not

affect SCC and BCC significantly, showing consistency with the earlier researches of Giosué et al. (2008). The effect of the season on the yield and composition of asinine milk is presented in Table 3.

The effect of the season on the milk yield was significant ($P<0.001$), as a result of nutrition deficiency during summer and autumn. Also, the season significantly affected the dry matter and milk protein content ($P<0.001$), as well as the milk protein content ($P<0.01$). The highest daily milk yield was found to be in spring, when pastures were abundant with vegetation. Giosué et al. (2008) also generally reported that asinine milk in spring time has the best quality and quantity production results. The lowest milk fat (0.22 %) and milk protein (1.43 %) content was found to be during summer, because, due to the absence of rainfall and presence of high temperatures, that period was deficient in vegetation and grazing. Correlation coefficients for individual parameters are presented in Table 4.

A significant positive correlation ($P<0.01$) was found to exist between milk yield and milk fat and the dry matter content, but there was no significant correlation to other composition components. Between dry matter, milk fat, milk protein and lactose content, as well as between SCC and BCC, significant correlation coefficients ($P<0.01$) were found. Significant correlation coefficients were also found between most of the other asinine milk components.

Conclusions

The population of the Littoral-Dinaric asses belongs to an endangered breed group, which makes the research of their production possibilities reasonable in order to preserve the population. The milk production of the Littoral-Dinaric asses in the predominant pasture keeping system was relatively modest. The lactation stage and the season significantly affected milk yield, dry matter, milk fat and the milk protein content. Further research of milk production, milk functionality, market development and production technology will help in a more complete utilization of the Littoral-Dinaric donkey.

Odlike laktacije, kemijskog sastava i higijenske kvalitete mlijeka primorsko-dinarskih magarica

Sažetak

Proizvodnja magarećeg mlijeka jedna je od mogućnosti gospodarske afirmacije dijela populacije magaraca. Primorsko-dinarski magarac brojnošću je dominantan, no, strukturalne promjene u ruralnim sredinama tijekom posljednjih desetljeća potisnule su ga u skupinu ugroženoga genetskog naslijeđa. Cilj istraživanja bio je utvrditi utjecaj stadija laktacije i sezone na proizvodni potencijal, laktacijske odlike, kemijski sastav i higijensku kvalitetu mlijeka primorsko-dinarskih magarica. Utvrđena prosječna proizvodnja mlijeka magarica iznosila je 172,12 mL/mužnji uz prosječan udjel mliječne masti od 0,33 %, bjelančevina 1,55 % i laktoze 6,28 %. Srednja vrijednost broja somatskih stanica je 4,09 log mL^{-1} a mikroorganizama 3,58 log mL^{-1}. Utjecaj stadija laktacije na količinu mlijeka i udjel suhe tvari bio je značajan ($P<0,01$), kao i na udjel mliječne masti i bjelančevina u mlijeku ($P<0,05$). Utvrđen je i značajan utjecaj sezone na proizvodnost, udjel suhe tvari i mliječne masti ($P<0,001$), kao i udjel bjelančevina u mlijeku ($P<0,01$). Proizvodnost primorsko-dinarskih magarica u pašnom sustavu držanja relativno je skromna, no, izravne i neizravne koristi od ovakvog vida proizvodnje višestruke su radi čega treba nastaviti razvijanje tehnologija ovog vida proizvodnje.

Ključne riječi: mlijeko magarica, proizvodnost, kemijski sastav, higijenska kvaliteta

References

1. Alabiso, M., Giosuè, C., Alicata, M.L., Mazza, F., Iannolino, G. (2008): The effects of different milking intervals and milking times per day in jennet milk production, *Animal 1*, 1-5.
2. Carroccio, A., Cavataio, F., Montaldo, G., D'amico, D., Alabrese, L., Iacono, G. (2000): Intolerance to hydrolyzed cow's milk proteins in infants: clinical characteristics and dietary treatment, *Clinical and Experimental Allergy 30*, 1597-1603.
3. Chiofalo, B., Salimei, E. (2001): Ass's milk: exploitation of an alimentary resource, *Riv. Folium 1*, 235-241.
4. Chiofalo, B., Azzara, V., Liotta, L., Chiofalo, L. (2004): I parametri chimico-fisici del latte di asina Ragusana nel corso dela lattazione, *Proceedings of the 6th congress 'Nuove acquisizioni in materia di Ippologia*, 77-84.

5. Dell'orto, V., Salimei, E., Bontempo, V., Fantuz, F., Toppino, P.M. (1993): Produzione e composizione di latte equino: osservazioni sperimentali, *Proceedings of the S.I.S.Vet*. XLVII, 2073-2077.
6. Doreau, M., Gaillard J.L., Chobert, J.M., Léonil, J., Egito, A.S., Haertlé, T. (2002): Composition of mare and donkey milk fatty acids and protein and consequences on milk utilization, *Proceedings of 4° Convegno Soc. Ital. Ippolog.*, 51-71.
7. Fantuz, F., Vincenzetti, S., Polidori, P., Vita, A., Polidori, F., Salimei, E. (2001): Study on protein fractions of donkey milk, *Proceedings of 14th Congress ASPA*, 635-637.
8. Giosuè, C., Alabiso, M., Russo, G., Alicata, L.M., Torrisi, C. (2008): Jennet milk production during the lactation in a Sicilian farming system, *Animal 2*, 1491-1495.
9. Guo, H.Y., Pang, K., Zhang, X.Y., Zhao, L., Chen, S.W., Dong, M.L. (2007): Composition, physiochemical properties, nitrogen fraction distribution, and amino acid profile of donkey milk, *Journal of Dairy Science 90*, 1635-1643.
10. HRN ISO 6731 (1999): Mlijeko, vrhnje, evaporirano mlijeko - Određivanje ukupne količine krutina, Hrvatski zavod za norme, Zagreb.
11. HRN ISO 1211 (2001): Mlijeko - Određivanje udjela masti - Gravimetrijska metoda, Hrvatski zavod za norme, Zagreb.
12. HRN EN ISO 9622 (2001): Punomasno mlijeko - Određivanje udjela mliječne masti, bjelančevina i laktoze. Upute za rad MID-infrared instrumentima, Hrvatski zavod za norme, Zagreb.
13. HRN ISO 5765-1 (2003): Mlijeko u prahu, mješavina sladoleda u prahu i prerađeni sir - Određivanje sadržaja laktoze - 1. dio: Enzimatska metoda uporabom glukoze preko laktoze, Hrvatski zavod za norme, Zagreb.
14. HRN ISO 4833 (2003): Mikrobiologija hrane i stočne hrane. Horizontalna metoda za brojenje mikroorganizama - Tehnika brojenja kolonija na 30 °C, Hrvatski zavod za norme, Zagreb.
15. HRN EN ISO 13366-2 (2007): Mlijeko - Brojanje somatskih stanica - 2. dio: Upute za rad Fluor-opto-elektronskim brojačem, Hrvatski zavod za norme, Zagreb.
16. Iacono, G., Carroccio, A., Cavataio F., Montalto, G., Soresi, M., Balsamo, V. (1992): Use of ass's milk in multiple food allergy, *Journal of Pediatric Gastroenterology and Nutrition 14*, 177-181.
17. ISO 21187 (2004): Milk-Quantitative determination of bacteriological quality - Guidance for establishing and verifying a conversion relationship between routine method results and anchor method results.
18. Ivanković, A., Caput, P., Mioč, B., Pavić, V. (2000): Fenotipske značajke magaraca u Hrvatskoj, *Agriculturae Conspectus Scientificus 65*, 99-105.
19. Malacarne, M., Martuzzi, F., Summer, A., Mariani, P. (2002): Protein and fat composition of mare's milk: some nutritional remarks with reference to human and cow's milk, *International Dairy Journal 12*, 869-877.
20. Matrtuzzi, F., Tirelli, A., Summer, A., Catalano, A.L., Mariani, P. (2000): Ripartizione delle sieroproteine nel latte dei primi due mesi di lattazione in giumente Sella Italiano, *Riv. Soc. Ital. Ippologia* 6, 21-27.
21. Monti, G., Bertino, E., Muratore, M.C., Coscia, A., Cresi, F., Silvestro, L. (2007): Eficiency of donkey's milk in treating highly problematic cow's milk allergic children: An vivo and in vitro study, *Pediatric Allergy and Immunology 18*, 258- 264.
22. Piccione, G., Fazio, F., Caola, G., Refinetti, R. (2008): Daily rhythmicity in nutrient content of asinine milk, *Livestock Science 116*, 323-327.
23. Pinto, F. Sportelli, G.F. (1998): Latte equino, alternativa molto interessante, *Informatore Zootecnico 10*, 57-59.
24. Salimei, E., Fantuz, F., Coppola, R., Chiofalo, B., Polidori, P., Varisco, G. (2004): Composition and characteristics of ass's milk, *Animal Research 53*, 67-78.
25. 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, *Italian Journal of Animal Science 4* (suppl. 2), 430-432.
26. SAS (1999): SAS Version 8. *SAS Institute Inc., Cary, NC*
27. Solaroli, G., Pagliarini, E., Peri, C. (1993): Composition and nutritional quality of mare's milk, *Italian Journal of Food Science 1*, 3-10.
28. Williams, C.M. (2000): Dietary fatty acids and human health, *Annalles de Zootechnie 49*, 165-180.
29. Wolter, R. (1996): Osteocondrosi e alimentatazione nel cavallo, *Riv. SIDI* 2, 27-32.
30. Zhang, X.Y., Zhao, L., Jiang, L., Dong, M.L., Ren, F.Z. (2008): The antimicrobial activity of donkey milk and its microflora changes during storage, *Food Control 19*, 1191-1195.