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ANTIOXIDANT CAPACITY IN DONKEY MILK (*Equus asinus*) DEPENDING ON LACTATION

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Abstract

Donkey milk is used as an alternative source in the diet of young children and newborns due to the similar composition to breast milk. The donkey milk is considered to be a functional food by the chemical composition it presents, thus being beneficial in the nutrition of people suffering from food allergies. The chemical composition and antioxidant capacity of the donkey milk are significantly influenced by lactation and also by the lactation period. Donkey milk has a low fat content compared to other species and high lactose content. These parameters are influenced by the variables such as: lactation, animal age, and feeding. The purpose of this study was to determine the effect of lactation on the antioxidant capacity and physicochemical compounds in the donkey milk.

Key words*: donkey, milk, lactation, antioxidant, fat, protein, lactose.*

INTRODUCTION

Donkey milk is used in different directions: for dairy products, creams, soaps and supplements for people suffering from food allergies (Piovesana et al., 2015; Coroian, 2018). It has a high a high antimicrobial activity and benefits the gastrointestinal and immune system. Due to its composition, it can be used against microbial infections and in the diet of people suffering from food allergies (Gubic et al., 2015; Longodor et al., 2018; Carminati et al., 2014; Cavallarin et al., 2015). Donkey milk has a rich chemical composition very similar to maternal breast milk, so it can be used in newborn nutrition (El-Hatmi et al., 2015; Polidori et al., 2009). The physico-chemical composition of milk varies according to species, individual, race, feed, lactation, health, season, climate and age (Coroian et al., 2016). Donkey milk can be used in the diet of people with atherosclerosis and hypercholesterolemia (Chiofalo et al., 2011). The composition in fatty acids suggests its consumption as a functional food for infant nutrition as well as in the diet of adults and susceptible persons (Martemucci et al., 2012; Martini et al., 2014). The chemical composition of milk and colostrum is influenced by feed, climatic conditions, lactation, animal health and housing conditions (Marchiş et al., 2018; Longodor et al., 2018; Coroian et al., 2016; 2017; Diaconescu et al., 2002; Martini et al., 2014). The physicochemical and amino acid composition of donkey milk according to lactation was studied by different authors (Guo et al., 2007; Polidori et al., 2009). Aspects related to the influence of nutrition and lactation on the composition of donkey milk are also shown in the studies of (Salimei et al., 2012). Compared to other species, donkey milk has a higher content of lysozyme. Moreover, lysozyme helps to reduce the number of bacteria, so it can be used to prevent intestinal infections in infants (Polidori et al., 2009). Ascorbic acid is present in donkey milk, which is also present in colostrum and breast milk. Ascorbic acid has a multitude of biochemical functions, such as maintaining a natural barrier against microbial infections (Vincenzetti et al., 2011).

Donkey milk was widely researched in various aspects, such as: mineral content at the different stages of lactation (Bilandzic et al., 2014); protein from donkey whey compared to other species (Brumini et al., 2015). Murua et al. (2013) studied the bactericidal activity of donkey milk, while (Monti et al., 2008) evaluated the influence of donkey milk on nutrition of children suffering from food allergies. Immunological aspects of donkey milk and the effect in preventing arteriosclerosis were studied by (Tafaro et al., 2007), while hygiene and health of donkeys was evaluated by (Pilla et al., 2010). Donkey milk contains nutrients such as proteins, fats, lactose and minerals that can also be detected in milk from other species. The difference between species is given by the different distribution of these nutrients. Protein content is influenced by breed, food, climate, season and udder health (Gubic et al., 2014; Hosoi et al., 2005; Yamawaki et al., 2005). The health of the animal and the udder influences the quality and quantity of milk. The highest milk production is realized in the third lactation. Between individuals and breeds there may be considerable variations in both productive and nutritional value of milk (Popelka et al., 2002). The purpose of this paper was to characterize the composition of donkey milk and antioxidant capacity under the influence of lactation.

MATERIALS AND METHODS

The donkey milk was harvested from lactating animals (lactation I-IV), from small farms in Cluj and Sălaj. Milk samples were collected individually in sterile containers and kept cool until physico-chemical analysis and antioxidant capacity were performed. Samples were harvested in the winter season.

Physico-chemical analysis of donkey milk

The physico-chemical parameters of donkey milk (fat, protein, lactose, water content and pH) were determined using Lactoscan apart.

Determination of the antioxidant capacity of the donkey milk

The ACL method (antioxidant capacity of lipid-soluble compounds) is used to determine the antioxidant capacity. The photochem V02 was used to measure the antioxidant capacity. The calibration and measurement of samples was based upon the inhibition of free radicals. After each measurement two purges of the apparatus were performed using ultrapure water. Determination of the amount of antioxidant capacity was achieved by establishing measurement curves that were compared to the measurement curves obtained for the standard solution. The calibration curve evaluation principle consists of: determining the integrated calibration curve. All the abovementioned calculations were made automatically using a software program called PCL soft.

RESULTS AND DISCUSSIONS

Physico-chemical composition of donkey milk

The physico-chemical composition analysed for donkey milk corresponds to the reference values for this species. The results are similar to those reported by (Longodor et al., 2018). Figure 1 show the fat content, which varies according to the harvesting and lactation area, as follows: 0.98% (L I) - 2.81% (L IV) for Cluj area and lower values for Sălaj area, 0.92% (L I) - 2.77% (L IV).

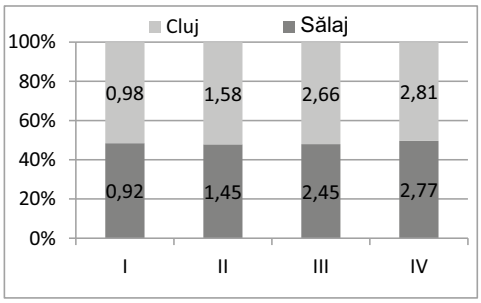

Figure 1. Fat content of donkey milk (%) (I-IV lactation period)

The average fat content of the donkey milk (0.3-1.8%) is similar to the observed values in horse milk (0.3-0.5%) and is much lower compared to other mammals (3.5-4-4% for human milk, 3.5-3.9% for cow's milk) (Guo et al., 2007; Polidori et al., 2009). One of the main causes of a lower fat content in milk is due to the incomplete removal of milk from the udder (Doreau et al., 1989; Caroprese et al., 2006). The amount of fat also varies during the lactation period, being higher in colostrum, and

decreases to the end of lactation (Gibbs et al., 1982). The protein content is influenced by lactation: (L I) - 1.68% and (L IV) - 1.94%, with the highest values in lactation IV (Figure 2). The protein in the donkey milk decreases from one month to the next, averaging 2%. The milk protein content was not influenced by the breed. On the contrary, milk protein content varied strongly during lactation and had a decreasing trend until 1.72 (g/100 g).

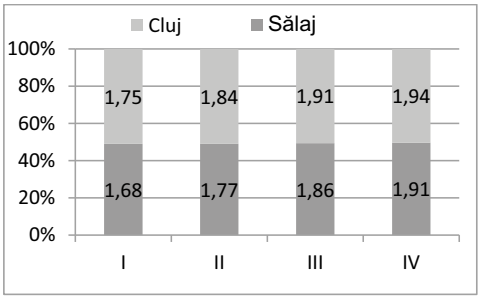

Figure 2. Protein content of donkey milk (%)
(I-IV lactation period)

Whey protein content remains constant during lactation. Whey protein content in the donkey 0.68 (g/100 g) is close to human and horse (Alabisio et al., 2005). In the present study, the protein content was lower in donkey milk than values reported by (Ling et al., 2008).

Lactose is the major disaccharide in milk, being an important parameter for donkey milk also, especially if we use milk to produce dairy products.

Donkey milk has a high content of lactose, with variation between 6.71% (L I) - 6.88% (L IV), for donkey milk in the Cluj area and 6.62% - (L I) and 6.91% (L IV) for Sălaj donkey milk (Figure 3).

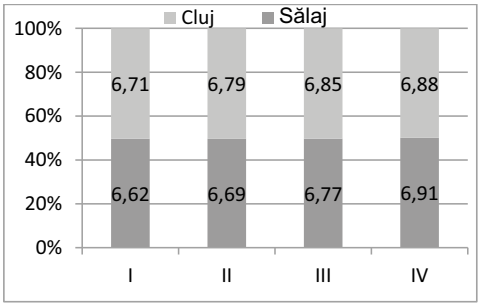

Figure 3. Lactose content of donkey milk (%)
(I-IV lactation period)

Swar et al. (2012) reports for donkeys and horses, that water has the highest content in the composition.

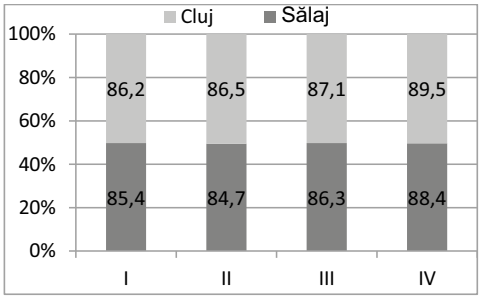

Figure 4. Water content of donkey milk (%)
(I-IV lactation period)

From the data reported by Salimei et al. (2004) and Guo et al. (2007), donkey milk has a pH between 7.14-7.22 and does not vary significantly during lactation compared to horse milk (Mariani et al., 2001).

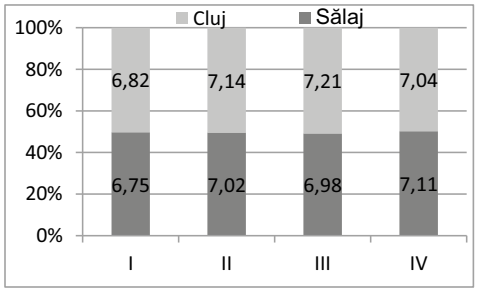

Figure 5. pH of donkey milk
(I-IV lactation)

The average pH (7.18) of the donkey milk is higher than that of cow's milk (6.6-6.7).

Antioxidant capacity of donkey milk

Donkey milk was considered a substitute for breast milk due to nutritional value and antioxidant properties, which can reduce disease (asthma, bronchitis, diabetes, anabrosis, gastritis, gastric ulcer) and oxidative stress (Beghelli et al., 2016; Lu et al., 2006; Ma et al., 2005; Nazzaro et al., 2010).

Figure 6 shows the mean values for the antioxidant capacity of donkey milk during four lactations in both areas (Sălaj and Cluj). The total antioxidant capacity in donkey milk varies between 16.02 U/ml and 17.55 U/ml (lactation IV), in the Cluj area.

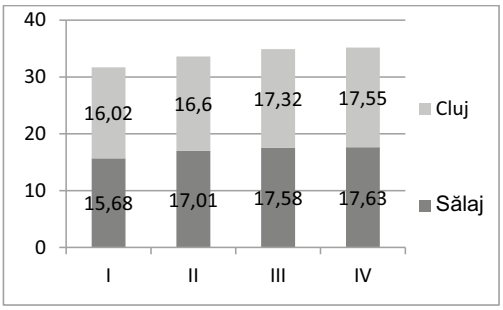

Figure 6. Total antioxidant capacity donkey milk (U/ml)

The antioxidant capacity of donkey milk in Sălaj area varied between 15.68 (U/ml) (L I) and 17.63 (U/ml) in the fourth lactation. In both studies areas, the third and fourth lactations showed the highest values.

These results are in the same line with those reported by Bucevic-Popovic et al. (2014) and Ling et al. (2018) in donkey milk. Donkey milk has a high antioxidant capacity; therefore it is used in the case of allergies, cardiovascular diseases and diabetes mellitus (Ling et al., 2018).

CONCLUSIONS

The physico-chemical composition of donkey milk was influenced by lactation. The highest content of fat, protein and lactose were observed in third and fourth lactation. In both studied areas (Sălaj and Cluj), the antioxidant capacity was influenced by lactation; the lowest content was observed in first and second lactation, while the highest in third and fourth lactation.

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