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Short Communication

Change in Morphometric Characteristics of Udder During Milking of Jenny

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MU drafted the manuscript, carried out data collection and made substantial contributions to basic idea. RM and DD carried out data collection and data preparation and performed the statistical analysis. SL has been involved in drafting of the manuscript.

Key words
Donkey, Udders, Morphometric parameters, Milking

ABSTRACT

Donkey breeding in both Europe and worldwide is gaining a momentum. An increasingly common reason for breeding donkeys is milk production. Unfortunately, donkey belongs to a group of rare domestic animals and systematic selection for their milk production has almost never been made. Donkey is most commonly used as a working animal. In order to examine the basic morphometric parameters of the udders of dairy donkeys, research was carried out on 15 dairy donkeys, bred on the farm of the Special Nature Reserve Zasavica in Zasavica near Sremska Mitrovica, in the Republic of Serbia. Donkeys are housed in groups in pens, without tethering. After milking, the foals were with them, and during milking mothers had visual contact with their foals. Milking was performed manually, and the amount of milk was determined by pouring it into a plastic measuring cup. Two milkings were performed two h apart. The average amount of milk obtained per day per donkey is 346.6 ml. There is a large variation interval between the minimum and maximum amount of milk obtained which indicates the heterogeneity of the individuals used in production and that there was no selection work for this type of production. The average amount of milk is smaller compared to Zapata where selection for milk production was made. Morphological characteristics of the udder differ statistically very significantly before and after milking, especially in relation to udder circumference, teat circumference and teat width. No statistically significant difference was found for the amount of milk obtained from left or right mammary complex.

Donkeys breeding became recently quite popular in Europe and all over the world, consequently breeder's number is steadily growing. One of the reasons for such popularity for these animals is their milk production, which was considered to be of little value until recently. A donkey belongs to a group of quite rare domestic animals, but no systematic selection criteria were framed on their specific characteristics. A donkey was considered just as a labor animal, which is no longer considered as a valid significance of this animal in the Northern Hemisphere. Donkeys are used in tourism and mostly for riding. A donkey is quite an intelligent animal so it is used more and more often for treating special-needs children. Besides that there is a number of health categories of people with various health problems who need donkey milk consummation. So, donkeys' milk is becoming more and more popular, but there are still a number of unknown characteristics in physiological as well as anatomical and technological sphere which need to be investigated. It should be mentioned now that milking of artiodactyls (cows, goats, sheep) differs very much from milking of perissodactyls (mare and jenny). Our research is focused specifically on anatomical udder characteristics of jenny before and after milking. Ivanković *et al*. (2014) have reported, the difference between artiodactyls and perissodactyls milking process which is clearly seen in milking frequency, per day and the duration of milking process. And also, that during the milking a jenny must keep an eye on the foal. The udder is anatomically placed quite peculiarly. The largest part (*Corpus mammae*) is in the inguinal area (*Regio inguinalis*), the most part of which is placed under the skin. The udder of the artiodactyls (cows, goats, and sheep) is also placed in the inguinal area, but it goes a little bit lower the abdominal wall. The udder of the perissodactyls (mare and jenny) is also placed in the inguinal area, but quite high, which makes sense because a low hung udder

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could make the movement difficult. The udder of the perissodactyls is anatomically placed quite peculiarly. The largest part (Corpus mammae) is in the inguinal area (Regio inguinalis), the most part of which is placed under the skin. The teats do not hang vertical down but go a bit towards the front (cranial). Thus, it makes it easier for the foal to suckle milk. During the suckling a foal usually places its body against the mother's one what makes it is easy to reach the teat. The udder of perissodactyls has two teats with two milky sinuses (Sinus lactifer) each, and of course two openings to the teats. That means that in the process of suckling two milk flows go from one teat. The udder has 4 mammary glands. Both udder halves the left and the right have two mammary glands the front and the rear ones. Very important factor for the milk production is the grade of the development of the glandular tissue of which consist the lactic alveoli where the process of secretion of the alveolar milk is going. This alveolar milk, when accumulated, goes down into the milk reservoir and after some stimulation reaches the teat and is ready for milking.

Materials and methods

The jennies at the Zasavica farm (Sremska Mitrovica) in Serbia were observed for the study of morphology parameters of the milking jenny udder. Groups of donkeys there are kept on the grounds on the loose. The foals stay with the jennies after milking and jennies had an eye contact with their foals during the milking.

It was hand-milking, the milk volume was measured by the graduated beaker. The jennies were milked twice a day with two h interval. They were given food in between and the foals stayed apart in the other ground at that time. The foals were let back to the jennies after the second milking. This experiment lasted 10 days straight. The jennies were milked in the same order and at the same time.

Parameters were taken by special linear with the sliding scale with vernier. They are the following: (1) udder circumference before and after milking, (2) udder depth before and after milking, (3) cranio-caudal diameter before and after milking, (4) latero-lateral diameter before and after milking, (5) left teat length before and after milking, (6) left teat breadth before and after milking, (7) right teat length before and after milking, (8) right teat breadth before and after milking, (9) left teat circumference before and after milking, (10) right teat circumference before and after milking

The same parameters were taken after the second milking, two h after the first one.

Results and discussion

Results of the milking are given it the Table I. The mean udder circumference before milking is 16.2 ± 4.1 cm, and after milking 11.4±2.5 cm. The udder depth varies from

Table I. Chenges in udder parameters of jennies and amount of milk produced during first and second milking.

Paremeter	Changes in paremeters after first milking		Changes in paremeters after second milking	
	Before milking (n=15)	**After milking (n=15)**	**Before milking (n=15)**	**After milking (n=15)**
Udder circumference	16.2±4.1 (9.0 – 26.0)	11.4±2.5*** (8.0 – 19.0)	12.3±3.7 (7.0 – 23.0)	9.9±2.5*** (7.0 – 17.0)
Udder depth	3.5±1.7 (2.1 – 11.6)	2.7±0.6** (1.7 – 4.2)	2.7±0.7 (1.8 – 4.7)	2.2±0.5*** (1.2 – 3.4)
Cranio caudal diameter	7.6±1.7 (4.7 – 11.0)	6.0±1.5*** (2.3 – 9.3)	6.8±1.8 (4.0 – 11.7)	5.5±1.3*** (3.3 – 8.4)
Latero-lateral diameter	5.8±1.6 (3.8 – 10.0)	4.3±1.2*** (2.5 – 6.8)	4.5±1.2 (2.8 – 8.7)	3.6±0.9*** (2.4 -5.7)
Left teat length	3.4±0.9 (2.1 – 6.0)	3.2±0.5*** (2.0 – 3.9)	3.5±0.7 (1.3 – 4.7)	3.1±0.5* (2.3 – 4.1)
Left teat breadth	2.2±0.5 (1.0 – 3.1)	1.5±0.3*** (1.0 – 2.1)	1.9±0.6 (1.1 – 4.0)	1.3±0.3*** (0.9 – 2.0)
Right teat length	4.3±0.5 (3.5 – 5.6)	3.6±0.5*** (2.7 – 4.7)	3.8±0.5 (2.9 – 4.7)	3.3±0.5*** (2.2 – 4.3)
Right teat breadth	2.2±0.4 (1.4 – 2.9)	1.5±0.4*** (0.9 – 2.1)	1.9±0.4 (0.9 – 2.7)	1.4±0.4*** (0.8 – 2.1)
Left teat circumference	7.7±1.7 (5.0 – 11.0)	5.6±1.2*** (4.0 – 9.0)	6.0±1.1 (4.0 – 8.0)	5.0±0.7*** (4.0 – 7.0)
Right teat circumference	7.6±1.4 (5.0 – 11.0)	5.7±1.0*** (4.0 – 9.0)	5.9±0.8 (5.0 – 8.0)	5.2±0.7*** (4.0 – 7.0)
Milk volume from left mammal halves	134.0±80.3 (40.0 – 360.0)		41.0±23.2 (10.0 – 115.0)	
Milk volume from right mammal halves	131.3±103.1 ^{ns} (30.0 – 400.0)		39.6±30.6 ^{ns} (10.0 – 115.0)	
Total milk volume	265.3±172.0 (70 – 760)		81.3±49.3 (20.0 – 230.0)	

*** very significant statistical difference; ** significant statistical difference; * statistical difference; ^{ns}no statistical difference.

2.1 cm to 11.6 cm before milking and from 1.7 cm to 4.2 cm after milking. Minimal cranio caudal diameter before milking is 4.7 cm and maximal – 11.0 cm. After milking the minimal diameter is 2,3 cm and maximal – 9,3 cm. Latero-lateral diameter before milking is from 3.8 to 10.0 cm, and after milking from 2.5 to 6.8 cm. The minimal left teat length before milking is 2.1 cm and maximal – 6 cm. After milking minimal left teat length is 2 cm and maximal – 3.9 cm. The mean left teat breadth before milking is 2.2 cm and after milking – 1.5 cm. The mean right teat length before milking is 4.3 ± 0.5 cm with variation coefficient 11.4%, and the mean right teat length after milking is 3,6 cm with variation coefficient 13.6 %. The right teat breadth before milking varies from 1.4cm to 2.9 cm, and after milking it is form 0.9cm to 2.1 cm. The mean left teat circumference before milking is 7.7 cm, after milking it is 5.6 cm. The mean right teat circumference is 7.6 cm before milking and 5.7 after milking. Actually all the parameters show very significant statistical difference. The significant difference is presented only by udder depth before and after milking.

Minimal milk volume of the first milking got from two left mammal halves of the udder (left mammal complex) is 40 ml, maximal – 360 ml. Mean milk volume from the left mammal complex is 134 ml. Minimal milk volume of the first milking got from the right mammal complex is 30 ml and maximal – 400 ml. The mean milk volume from the right mammal complex is 131.3 ml. The total mean volume of the first milking from the right mammal complex is 265.3 ml with variation interval from 70 to 760 ml. There is no significant statistical difference in the milk volume got from left or right mammal complex.

The second milking was done in two h after the first one. The results on each parameter are given in the Table. The minimal measured udder circumference before milking is 7.0 cm, maximal – 23.0 cm. Minimal udder circumference after milking is 7.0 cm and maximal – 17.0 cm. Mean udder circumference before milking is 12.3 cm and after milking – 9.9 cm. Mean udder depth before second milking is 2.7 cm and after milking – 2.2 cm. Variation interval of the udder depth before milking is from 1.8 to 4.7 cm and after milking from 1.2 to 3.4 cm. Cranio caudal diameter before milking is 6.8 cm and after milking – 5.5 cm. Mean latero-lateral diameter before milking is 4.5 cm and after milking – 3.6 cm. The left teat length varies from 1.3 to 4.7 cm before milking and from 2.3 to 4.1 cm after milking. Mean left teat breadth before milking is 1.9 cm and 1.3 cm after milking. The right teat length varies from 2.9 to 4.7 cm before milking and from 2.2 to 4.3 after milking. Mean right teat breadth before milking is 1.9 cm and 1.4 cm after milking. The left teat circumference is 6.0 cm before milking and 5.0 cm after milking. Mean right teat circumference is 5.9 cm before milking and 5.2 cm after milking. There is very significant statistical difference of parameters before and after milking, except for the left teat length with significant statistical difference.

The milk volume from the left mammal complex varies from 10.0 to 115.0 ml with the mean milk volume at the second milking from the left mammal complex – 41.0 ml. The mean milk volume at the second milking from the right mammal complex is 39.6 ml with variation interval from 10.0 to 115.0 ml. The total milk volume at the second milking varies from 20.0 to 230.0 ml with mean amount – 81.3 ml. There is no significant statistical difference of milk volume from right and left mammal complexes at the second milking as well as at the first one.

There is no published data in accessible literature on udder morphologic parameters of the milking jennies before or after milking. Very significant difference was discovered of almost all the surveyed udder parameters before and after milking. That means significant morphological difference of jenny's udder before and after milking.

The total mean milk volume of two milking during two h a day is 346.5 ml. Variation interval is from 90 ml to 990 ml that makes quite a big range and shows the lack of well-organized selection based on milking volume. Mean milk volume got from milking jennies in the nature ground Zasavica is higher than the volume got from Primorsko-Dinaric donkey breed in Croatia. Ivanković *et al.* (2009) state that the mean volume per a milking of jennies of that breed is 172.12 ml. A few years later Ivanković *et al.* (2014) published information on milk yield of Istrian donkeys where they specified the mean milking yield as 745.38 ml per a milking, which is much higher than yield of jennies in Zasavica. According to Savić-Radovanović *et al.* (2018) the mean yield varies from 350 to 850 ml per a milking

Information on milk volume depending on the day or night time of milking is worth to mention. Salimei *et al.* (2004) state that the milk volume of the morning milking 549.2 ml is less than 949.3 ml of the evening milking. The milk volume also changes by seasons. Polidori *et al.* (2009) state that mean milk quantity per day in Autumn is 1.4+/-0.1 kg, in winter 2.0+/-0.2 kg, in spring 1.5+/-0.1 kg and 1.7+/- kg in summer. Time length between milking affect the milk yield. During the experiment the time period between the first and the second milking was two h and the milking was done in the morning. In this milking schema, according to the author, the milk yield was less than when the time period between milking was bigger and the milking was done in the evening. Ivanov and Bogdanović (2021) state that *Balkan jennies* gave 1.4

L milk per day with 6 h milking interval and 1.19 L milk per day with 3 h interval. The udder capacity of jenny is not big that determines specific milking characteristics. At frist, the milk reservoir volume is not big, it is 0.5 L to 2.0 L (Ivanković *et al*., 2014). That means that jennies are milked every 2-3 h. Ivanković *et al*. (2014) recommend to milk jennies only at a day time and let the foals quietly suckle at night. These author say that machine milking increases yield up to 30%.

Conclusion

The milking of livestock in Zasavica ground was done in the morning with 2 h interval between the first and the second milking. Mean milk volume from one jenny per day was 346.6 ml. There is a big difference between minimum and maximum milk yield per a jenny. That means diversity in milk producing jennies and the fact that no selection has been conducted till nowadays. The mean milk yield is less than milk yield in those places where the selection work for livestock was held. The morphologic udder characteristics before and after milking statistically differ very significantly, especially the udder circumference, the teat circumference and the teat breadth. Statistically significant difference in milk volume from left or right mammal complex is not found. It should be paid more attention in the future to selection work on yield increasing and interval lengthening between two milking times. It would also be desirable to implement the following measures in order to increase milk yield: (1) Carry out new research on more types of donkeys, (2) Monitor the length of all lactation and correlate it with udder morphometric parameters, (3) Based on the results of the monitoring, select the parent pairs, (4) Do a performance test on milk yield, (5) Sires that produced female progeny with good udder conformation should be mated in line to check transmission of desirable udder shape and desirable milk yield, (6) Female offspring from mothers with good milk yield and good udder conformation must be left for herd overhauled.

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IRB approval

Since no invasive methods were used during the research on animals there was no need for an ethics committee approval.

Ethical statement

During the whole period research trail, the jenny were provided freedom from hunger, thirst and pain. A suitable environment was provided to express the natural behavior.

Statement of conflict of interest

The authors have declared no conflict of interest.

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