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A QUARTER INDIVIDUAL MILKING MACHINE "STIMULACTOR®" IN A CAMEL FARM IN SWITZERLAND: ACCORDING TO FIELD STUDY

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ABSTRACT

The aim of the field study was to test the performance of the quarter-individual milking machine "StimuLactor" (ST-C) in a camel farm in Switzerland. Eight one-humped lactating dromedaries were used for this purpose. The camels were milked twice a day with a unit milking machine-StimuLactor for camels. The setting of the milking machine was as follows: vacuum level 36 kPa, pulsation rate 90 cycles/min and, pulsation ratio 65/35. In addition, the milking machine was equipped with sequential pulsation (25% offset quarter to quarter) and the teat cups are equipped with round silicone liners and an air inlet valve (Bio-Milker). Daily milk yield was recorded over a period of one year and milk samples were taken for qualitative analysis. The results have shown that after using the new milking machine no pathogenic bacteria were detected in the milk produced during the trial period. The examined milk parameters fat, protein, lactose, somatic cell count (SCC) and non-pathogenic bacteria (NPB) were in the physiological range and the concentration were 3.33%, 2,39%, 4.09%, 79000 cells/ml and 6150 b/ml, respectively. Finally, milking with StimuLactor has shown very good results, since this milking machine has been adapted to the anatomical, morphological and physiological characteristics of the camel's udder.

Key words: Camel, fat, lactose, milking machine, protein, SCC, StimuLactor

Camel milk is still the most important nutritional source for pastoralists in rural areas in Asia and Africa. However, in the last 2 decades, camel milk has been in great demand in Europe and north America (Dijk, 2021), because camel milk has several minor components that have special bioactive properties. These are present at significant concentrations and are extremely important and beneficial for human diet and health (Kaskous, 2016; Kaskous and pfaffl, 2017; Sumaira Shah *et al,* 2020; Swelum *et al,* 2021; Ismail *et al,* 2022; Behrouz *et al,* 2022). Therefore, the amount of camel milk needs to be increased to meet the demand. To increase the milk yield for each camel and to improve the quality as well as the safety of raw camel milk, machine milking must be used instead of hand milking (Hammadi *et al,* 2010; Nagy and Juhasz, 2016; Kaskous, 2018). Nowadays, the development of milking technology is making great strides. A special modern milking machine for camels "StimuLactor" (ST-C) was developed in 2018 by Siliconform, Germany and has been used in practice since then (Kaskous, 2019a; 2021a; 2023). This new milking technique has not only improved milk yield and quality, but also the working conditions for the milkers and the welfare of the camels (Kaskous, 2023). Fast milking and above all complete milking is a matter of course in the StimuLactor milking system. In addition, this new milking technique was adapted to the morphological, anatomical and physiological requirements of camels (Kaskous, 2019a). The aim of this field study was therefore to demonstrate the efficiency of the StimuLactor milking machine on a commercial camel farm.

Materials and Methods

The experiments of this study were conducted in compliance with the requirements of the Swiss animal protection and welfare law.

Animals and Housing

Eight one-humped lactating camels from a commercial camel farm in Switzerland were used. The camels varied in parity numbers and stages of lactation. The camels were kept outdoor most of the time. However, at night and in the cold winter they were kept in a loose housing system. Camels were fed primarily on pasture grass and were also provided

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with grass hay and supplements of vitamins and minerals. Drinking water was administered *ad libitum*.

Milking Equipment and Properties

The camels were milked twice a day with a unit milking machine - StimuLactor for camels (Siliconform, Germany) (Fig 1). The working vacuum level was 36 kPa and sequential pulsation (25% offset quarter to quarter) was adopted. The pulsation rate was 90 cycles per minute and the pulsation ratio was 65/35 during the milking time. The main characteristics of the milking machine used were as follows:

- It was an easily handled and animal- as well as person-friendly semi-automatic milking system that differed technically and impressively from conventional milking machines.
- It was based on a quarter-individual milking system. This meant that teat cups worked completely independently of each other (without a claw).
- The teat cups were equipped with round silicone liners and an air inlet valve (called Bio-Milker).
- The teat cups could be easily attached to the teat with one hand. In this way, accidents, or injuries to the milker during milking were avoided.
- The milking machine milks as the calf suckles, so the calf did not have to be present during milking.
- In addition, the system included a very special pre-stimulation program and an excellent cleaning and sanitary process.

The milking routine

The milking routine was performed according to the usual routine of the farm. This included pre-milking preparations, in which the teats were cleaned with a wet udder tissue and afterwards dried with another tissue. Then, each teat cup was individually or in pairs manually attached to the teats. After this step, the system was started on the control display and stimulation began. The system was programmed to intensively stimulate through a standard pulse rate (90 cycles/min) and a reduced milking phase (bphase)of 10 % over a period of 90 s. Simultaneously, additional stimulation was reached through intensive movement of the teat cups by an actuator. This mechanical arm supports the four milk tubes. During the stimulation phase and the milking phases the arm moved up and down. This movement was transferred to the teat cups and made the teats erect. With this method, the liners apply a vibratory massage to the udder and teats, like the calf would do during suckling. After this stimulation phase the main milk phase began and the milk flow was observed on the display. When the milk flow decreased to a certain level, the milking process was automatically stopped by detaching the milking unit. After all animals had been milked, the milking system was cleaned.

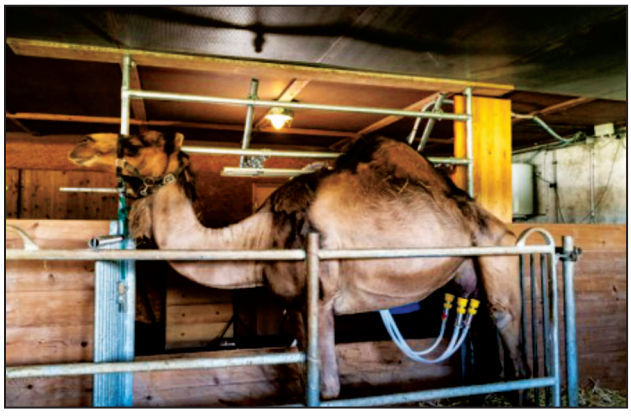

Fig 1. A StimuLactor milking machine during milking in a camel farm in Switzerland.

Milk sampling and milk analysis

Daily milk yields were recorded and milk samples were taken for qualitative analysis for a period of one year after the introduction of the new milking machine. The milk samples were examined by the animal health service and the Milchprüfring Bavaria e. V.

Statistical Analysis

For statistical analysis, the SAS program (version 9.2. SAS Institute Inc.) was used. The results were presented as arithmetic means and standard errors.

Results and Discussion

- Findings of bacteria in the examined milk samples.

The milk analysis has shown that after installing the new milking machine no pathogenic bacteria were to be found in the milk produced during the trial period. These results clearly showed that the StimuLactor milking machine is adapted to the camel's udder. Thus, milking machine design and function are critical for rapid and efficient removal of milk without damaging the teat and without transmitting pathogenic microorganisms that might cause mastitis. Similar results were shown by Kaskous (2019a). The milk remained clean and free from pathogenic bacteria. Furthermore, it has been shown that the use of machine milking is preferable to hand milking, since the contamination with pathogenic bacteria was very high in hand milking compared to

machine milking (Saleh and Faye, 2011). It has also been found that improper use of the milking machine, especially improper use of liners, can damage the camel's udder and lead to oedema and promote the colonisation of *Staphylococcus aureus* during the time of machine milking (Juhasz and Nagy, 2008). New results from Tunisia showed that the use of machine milking in the field was associated with increased milk yields but that in also caused an increased microbial load compared to hand milking (Atigui *et al,* 2023). These results emphasise that improper use of the milking machine has a negative impact on teat health. Apparently, the good results of this study are due to the use of a lower vacuum (36 kPa) in the milking machine. The use of high vacuum for camels could lead to udder health problems, which are reflected by high SCC in the milk produced and a negative impact on the health status of the teat (Kaskous, 2018).

Camel milk parameters

As shown in Table (1), the mean of fat concentration in the camel milk was 3.33±0.07%. This value was within the normal range for camel milk and meets other study results (Siboukeur, 2007; Chethouna, 2011; Nagy *et al,* 2013; Benyagoub *et al,* 2013; Alwan *et al,* 2014; Kaskous, 2019a). However, fat content of camel milk varies greatly between 2% and 5% in the literature depending on many factors such as parity, stage of lactation, breeds, weather conditions, feed, presence of water, country, weaning time and milking methods (Hassan *et al,* 2007; Haddadin *et al,* 2008; Bekele *et al,* 2011; Mustafa *et al,* 2020; Bakry *et al,* 2021; El-Hanafy *et al,* 2023).

The mean content of camel milk protein was 2.39±0.03% (Tab. 1) and it ranged between 2.17±0.05% and 2.57±0.07%. This protein concentration correlates with various studies (Ellouze and Kamoun, 1989; Raghvendar et al, 2004; Bakheit et al, 2008), while it appears quite low, compared to other author's results (Mal *et al,* 2006, 2007; Yadav *et al,* 2015). Indeed, this protein content in camel milk can be normal under Swiss conditions, since water is free and green fodder or hay is available all year round. Under these conditions, the protein synthesis in the udder were in the physiological range.

The average lactose content in camel milk was 4.09±0.03% and ranged from 3.91±0.04% to 4.16±0.04% (Tab. 1). Similar results were reported by Hassan *et al* (1987); Elamin and Wilcox (1992); Wangoh *et al* (1998); Raghvendar *et al* (2004); Kouniba *et al* (2005); Haddadin *et al* (2008) and Smits *et al* (2011). However, many researchers reported that lactose concentration of camel milk varied between 2.4% and 5.8% (Khan and Iqbal, 2001; Konuspayeva *et al,* 2009; Karaman *et al,* 2022). Faraz (2020) reported lactose contents from 4.8-5.8%, which are slightly higher than those of cow's milk.

The mean SCC in raw camel milk was 79000±23000 cells/ml and it ranged between 66000 and 118000 cells/ml (Tab. 1). Under Swiss conditions, this SCC concentration was normal and within the physiological range. Kaskous (2021b) reported that a SCC 150000 cells/ml in camel milk was a threshold value for healthy camels and that it is within physiological values. SCC in camel milk could be the main indicator of milk hygiene, milk quality and udder health (Hadef *et al,* 2016). Results from literature studies have shown that SCC were higher in camel milk compared to these results. The investigation by Hamed *et al* (2012) found that the arithmetic means of SCC in camel milk were 100000 cells/ml. Another study found that the mean SCC in raw camel milk from healthy udders under German conditions was 126430±7210 cells/ ml (Kaskous, 2019a). The concentration of SCC in Saudi Arabia has been obtained by Saleh and Faye (2011) and the mean value of SCC was 125000 cells/ml. The results from Golestan province in Iran have shown that out of 243000 cells/ml in camel milk samples from individual quarters (95 milking camels), 18.1% were subclinical mastitis and that SCC values beyond 306000 cells/ml could be considered as subclinical mastitis in the camel (Niasari-Naslaji *et al,* 2016). Abbood (2016) suggested that an SCC value of 250000 was specified as the limit value for a healthy camel.

The mean value of NPB in raw camel milk was 6150±230 b/ml and it ranged between 5780 and 6330 b/ml. This non-pathogenic germ count in the raw camel milk was normal during the experiment and the udders remained healthy. Kaskous (2019b) reported that raw milk from a healthy udder contained a very low concentration of microorganisms, typically less than 1000 colony-forming units of total bacteria per ml (cfu/ml). It is important to remember that the milk from a healthy udder was virtually sterile (Johnson *et al,* 2015), since the camels udder was protected by a variety of defense mechanisms such as innate or specific immunity and physiological peculiarities and that it was only contaminated with germs when passing through the teat canal (Zangerl, 2007). However, the germs that got into the milk cause from the surface of the udder and teats, the stall, the feed, the milker, the air, the water and the milking machine (Kaskous,

2019b). Anyway, the number of NPB was low in this study, because the farm condition is ideal.

Table 1. Average of camel milk parameters during the experimental period.

Parameter	N	Concentration
Fat %	208	3.33±0.07
Protein %	208	2.39±0.03
Lactose %	208	4.09±0.03
SCC Cells/ml	208	79000±23000
Non-Pathogenic Bacteria /ml	208	6150±230

Conclusion

- The results of this study clearly showed that the quarter-individual camel milking machine "StimuLactor" is adapted to the anatomical, morphological and physiological needs of camel udders.
- The milking machine ST-C is easy for the milker to use and requires less effort compared to conventional milking machine.
- The calves do not need to be present during milking as this milking machine mimics the way the calf suckles.

References

Abbood AS. Compare between somatic cell count (SCC) in she camel and cow milk and genetic study. Indian Journal Research. 2016; 5(7):145-146.

Alwan OA, Lgwegbe AO and Ahmad AA. Effects of rearing conditions on the proximate composition of Libyan Maghrebi camels (*Camelus dromedarius*) milk. International Journal of Engineering & Applied Science. 2014; 4:1-6.

Atigui M, Fguiri I, Arroum S, Brahmi M, Ghzaiel B and Hammadi M. Effect of milking routines and hygiene practices and evolution along the market value chain on raw camel milk quality in Tunisia. Italian Journal of Animal Science. 2023; 22(1):337-346.

Bakheit SA, Majid AM and Nikhala A. Camels (*Camelus dromedarius*) under pastoral systems in North Kordofan, Sudan: Seasonal and parity effects on milk composition. Journal of Camelid Science. 2008; 1:32-36.

Bakry IA, Yang L, Farag MA, Korma SA, Khalifa I, Cacciotti I, Ziedan NI, Jin J, Jin Q and Wei W. A comprehensive review of the composition, nutritional value and functional properties of camel milk fat. Foods. 2021; 10:2158.

Behrouz S, Saadat S, Memarzia A, Sarir H, Folkerts G and Boskabady MH. The antioxidant, anti-inflammatory and immunomodulatory effects of camel milk. Frontiers in Immunology. 2022; 13:855342.

Bekele T, Lundeheim N and Dahlborn K. Milk production and feeding behaviour in the camel (*Camelus dromedarius*) during 4 watering regimens. Journal of Dairy Science. 2011; 94:1310-1317.

Benyagoub E, Ayat M, Dahan T and Smahi K. Level of control of the hygienic quality of camel milk (*Camelus dromedarius*) in south west Algeria and its impact on security. Peak Journal of Food Science and Technology. 2013; 1:53-60.

Chethouna F. Study of physicochemical, biochemical characteristics and the microbiological quality of pasteurised camel milk, in comparison with raw camel milk: Memory Magisterium in Applied Microbiology. University Kasdi Merbah Ouargla. 2011.

Dijk Z. The rise of camel milk. www.dairyglobal.net/the rise of camel milk/dairy Global. Published: 29.10.2021

Elamin F and Wilcox C. Milk composition of Majaheim camels. Journal of Dairy Science. 1992; 75:3155-3157.

El-Hanafy AA, Saad YM, Alkarim SA, Almehdar HA, Alzahrani FM, Almatry MA, Uversky VN and Redwan EM. Yield and composition variations of the milk from different camel breeds in Saudi Arabia. Science. 2023; 5:1-15.

Ellouze S and Kamoun M. Evolution of the composition of the dromedary milk according to the stage of lactation. Mediterranean Options-Seminar Series. 1989; 6:307-311.

Faraz A. Composition of camel milk: A Blessing for Health. Annals of Public Health and Epidemiology-APHE 1(2): 2020.APHE.MS.ID.000509.

Haddadin MS, Gammoh SI and Robinson RK. Seasonal variations in the chemical composition of camel milk in Jordan. Journal of Dairy Research. 2008; 75:8-12.

Hadef L, Aggad H, Hamad B, Mahmoud MS and Adaika A. Subclinical mastitis in dairy camels in Algeria: Comparison of screening tests. Acta Argiculturae Slovenica. 2016; 108(2):85-92.

Hamed H, Trujillo A-J, Juan B, Guamis B, Elfeki A and Gargouri A. Interrelationships between somatic cell counts, lactation stage and lactation number and their influence on plasmin activity and protein fraction distribution in dromedary (*Camelus dromedarius*) and cow milk. Small Ruminants Research. 2012; 105:300-307.

Hammadi M, Atigui M, Ayadi M, Barmat A, Belgacem A, Khaldi G and Khorchani T. Training and short time effects of machine milking on milk yield and milk composition in Tunisian Maghrebi camels (*Camelus dromedarius*). Journal of Camel Practice and Research. 2010; 17(1):1-7.

Hassan AH, Hargrass AI, Soryat KA and El- Shabrawy SA. Physicochemical properties of camel milk during lactation period in Egypt. Egyptian Journal of Food Science. 1987; 15(1):1-14.

Hassan RA, El Zubeir IE and Babiker S. Effect of pasteurization of raw camel milk and storage temperature on the chemical composition of fermented camel milk. International Journal of Dairy Science. 2007; 2:166-171.

Ismail LC, Osaili TM, Mohamad MN, Zakaria H, Ali A, Tarek A, Ashfaq A, Al Abdouli MA, Saleh ST, Al Daour R, Al Rajaby R, Stojanovska L and Al Dhaheri AS. Camel milk consumption patterns and perceptions in the UAE: a cross-sectional study. Journal of Nutritional Science. 2022; 11: e 59.

Johnson B, Joseph M, Jose SH, Jose S, Kinne J and Wernery U. The microflora of teat canal and udder cistern in non-

lactating dromedaries. Journal of Camel Practice and Research. 2015; 22(1):55-59.

Juhasz, J and Nagy P. Challenges in the development of a large-scale milking system for dromedary camels. In: Nagy, P., G. Huszenicza and J. Juhasz (Eds.). WBC/ ICAR Satellite Meeting on Camelid Reproduction, Budapest, Hungary. 2008; pp 1-4.

Karaman A, Akgül FY, Ogut S, Canbay HS and Alvarez V. Gross composition of raw camel's milk produced in Turkey. Food Sci. Technol. Campinas. 2022; 42:e59820.

Kaskous S and Pfaffl MW. Bioactive properties of minor camel milk ingredients- An overview. Journal of Camel Practice and Research. 2017; 24(1):15-26.

Kaskous s, Al-Momani AQ, Al-Yacoub AN, Al-Najjar KA. Physiological Perspective of milk somatic cell count in lactating camels. Journal of Camel Practice and Research. 2021b; 28(3):319-325.

Kaskous S. A new milking technology: "StimuLactor" for lactating camels. Journal of Camel Practice and Research 2021a; 28(1):1-9.

Kaskous S. Camel milk composition, udder health and effect of different storage times and temperatures on raw milk quality using camel milking machine "StimuLactor". Agriculture and Food Sciences Research 2019a; 6(2):172-181.

Kaskous S. Importance of camel milk for human health. Emirates Journal of Food and Agriculture 2016; 28(3):158-163.

Kaskous S. Importance of liner design and milking machine settings for optimal milking performance and welfare in camels. The 6th Conference of the International Society of Camelid Research and Development (ISOCARD) "The role of Camel in Food Security and Economic Development" King Faisal University, Al Ahsa, Saudi Arabia, march 12-16, 2023; pp 37.

Kaskous S. Physiology of lactation and machine milking in dromedary she-camel. Emirate Journal of food and Agriculture. 2018; 30(4):295-303.

Kaskous S. Prevalence of microbes in raw camel milk-an Overview. IOSR Journal of Agriculture and Veterinary Science. 2019b; 12(2) Ser. I:51-60.

Khan BB and Iqbal A. 2001. Production and composition of camel milk-review. Pakistan Journal of Agricultural Sciences. 2001; 38(3-4):64-68.

Konuspayeva G, Faye B and Loiseau G. The composition of camel milk: A meta-analysis of the literature data. Journal of Food Composition and Analysis. 2009; 22:95-101.

Kouniba A, Berrada M, Zahar M and Bengoumi M. Composition and heat stability of Moroccan camel milk. Journal of Camel Practice and Research. 2005; 12:105-110.

Mal G, Sena DS and Sahani M. Changes in chemical and macro-minerals content of dromedary milk during lactation. Journal of Camel Practice and Research. 2007; 14:195-197.

Mal G, Sena DS, Jain VK and Sahani MS. Therapeutic value of camel milk as a nutritional supplement for multiple drug resistant (MDR) tuberculosis patients. Journal of Veterinary Medicine. 2006; 61:88-94.

Mustafa AB, Faraz A, Baum D, Elgenaidi A, Bashari M, Alkaskas A and Elhag A. Impact of early weaning on constituents and nutritional values of camel milk in modern system. Open Veterinary Journal. 2020; 10(2):232-238.

Nagy P and Juhasz J. Review of present knowledge on machine milking and intensive milk production in dromedary camels and future challenges. Trop. Anim. Health Prod. 2016; 48(5):915-926.

Nagy P, Thomas S, Marko O and Juhasz J. Milk production, raw milk quality and fertility of dromedary camels (*Camelus dromedarius*) under intensive management. Hungarian Veterinary Act. 2013; 61:71-84.

Niasari-Naslaji A, Pezeshk H, Atakpour AB, Ghaffari S, Nickchi P, Safi S, Shirazi-Beheshtiha SH, Arabha H, Samiei R, Amjadi M, Haji Moradlou AA, Narimani I and Moosavi-Movahedi AA. Estimation of somatic cell count, as gold standard to detect subclinical mastitis, in dromedary camel. Journal of Camel Practice and Research. 2016; 23(1):175-178.

Raghvendar S, Shukla S and Sahani MS. Chemical and physico-chemical properties of camel milk at different stages of lactation. International Conference on Saving the camel and Peoples Livelihoods, Lokhit Pashu-Palak Sansthan, Sadri, Rajasthan, India, 23-25 November. 2004; pp 37.

Saleh SK and Faye B. Detection of subclinical mastitis in dromedary camels (*Camelus dromedarius*) using somatic cell counts, California mastitis test and udder pathogen. Emirates Journal of Food and Agriculture 2011; 23:48-58.

Siboukeur O. Study of camel milk collected locally: physicochemical and microbiological characteristics, skills coagulation. Ph D Thesis in Agricultural Sciences. Institute National Agronomique El-Harrach-Algiers. 2007.

Smits MG, Huppertz T, Alting AC and Kiers J. Composition, constituents and properties of Dutch camel milk. Journal of Camel Practice and Research. 2011; 18(1):1-6.

Sumaira Shah AM, Solangi GA, Anwar I and Kalwar Q. Composition and beneficial impact of camel milk on human health. Punjab University Journal of Zoology. 2020; 35(2):179-189.

Swelum AA, El-Saadony MT, Abdo M, Ombarak R, Hussein EOS, Suliman G, Alhimaidi AR, Ammari A, Ba-Awadh H, Taha AE, El-Tarabily KA and El-Hack A. Nutritional, antimicrobial and medicinal properties of camel's milk: A review. Saudi Journal of Biological Sciences. 2021; 28(5):3126-3136.

Wangoh J, Farah Z and Puhan Z. Composition of milk from three camel (*Camelus dromedarius*) breeds in Kenya during lactation. Milchwissenschaft 1998; 53:136-139.

Yadav AK, Kumar R, Priyadarshini L and Singh J. Composition and medicinal properties of camel milk: a review. Asian Journal of Dairy and Food Research. 2015; 34:83-91.

Zangerl P. Mikrobiologie der Produkte. In: Krömker V. Kurzes Lehrbuch Milchkunde und Milchhygiene, Pary. 2007; pp 156-179.