

Milk-sucking in Cows and Buffaloes of Egyptian Western Area with Special Reference to the Outcome of Treatment

Mohamed A.H. Abdelhakiem¹, Salah M. Soliman², Ahmed F. Ahmed^{*}

¹Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Assiut University, Assiut 71526, Egypt.

²Postgraduate student, Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Assiut University, Assiut 71526, Egypt.

*Correspondence

Ahmed F. Ahmed
E-mail address: afahmed70@aun.edu.eg

Abstract

Milk-sucking (self-sucking and inter-sucking) is an anxious problem causing economic losses in dairy farms. Although several studies were conducted to elucidate the main cause, the etiology is still unclear and might be a multi-factorial problem. The present study aimed to meticulously study individual cases of milk-sucking as well as the outcome of conservative and surgical treatment in cows and buffaloes. One hundred self-sucking cows and buffaloes were admitted to different clinics of Elkharga city in New-Valley Governorate between January 2019 and August 2020. Complete clinical examination of the animals was conducted. The recorded data were the history, signalment of the animals, clinical findings, associating problems and response to conservative treatment. Forty cows were treated conservatively through the application of the plastic nose (n=27) or mouth rings milk-sucking preventer (n=13). Surgically operated animals were divided into two groups according to the surgical technique. Twenty animals (cows=14, buffaloes=6) were subjected to ventral partial glossectomy, and the other ten cases (cows=6, buffaloes=4) were treated using inverting technique (tongue reshaping). The results revealed good body condition, normal physiological parameters, good appetite, good fertility and conception rate and good milk yield in 70 cases. Thirty animals had suffered depraved appetite, nutritional deficiency and delay of post-partum estrus and ovulation. Fore teats were the most common sites for milk-sucking. Cross-sucking in the calf-hood period, energy and some mineral deficiency, and overcrowding in the markets might be the main causes of milk-sucking. Conservative treatment was effective as far as the device present in situ. Ventral glossectomy was better than tongue reshaping in treatment of the milk-sucking in cows and buffaloes.

KEYWORDS

Self-sucking, Inter-sucking, Glossectomy, Tongue reshaping

INTRODUCTION

Milk-sucking in large ruminants is considered a devastating and challenging problem, which has increasing incidence over time. Previous studies had looked for the main causes behind this undesirable trait (Allmacher, 1998; Abou-El-Ella, 1999; Debreceni and Juhás, 1999). Other studies strived to find a solution and treatment for this vice. These studies had concluded that milk-sucking is a multifactorial problem causing large losses in the dairy farms as a result of considerable milk losses, injuries to the teats and udder, mastitis, and increased cost of veterinary care costs (Jensen and Klyn, 2000; Keil *et al.*, 2001; Lidfors and Isberg, 2003). The management, housing, way of raising calves before weaning, feeding system, nutritional deficiencies, associating diseases, and genetic factors all are accused for development of milk-sucking in animals (Bademkiran *et al.*, 2006; Seddek *et al.*, 2019).

The present study aimed to investigate cases of milk-sucking (self-sucking and inter-sucking) cows and buffaloes of western area in Egypt with special reference to the outcomes of conservative and surgical treatments that were carried out to prevent

this abnormal behavior.

MATERIALS AND METHODS

The research was ethically approved by the Animal Care and Welfare Committee, Faculty of Veterinary Medicine, Assiut University, Assiut, Egypt. All institutional ethical regulations were followed during the study procedures.

One hundred milk-sucking animals (cows=90 and buffaloes=10) were admitted to different clinics of Elkharga city in New-Valley Governorate between January 2019 and August 2021. A thorough and complete examination of the animals was conducted. Only multiple self-suckers or inter-suckers that were confirmed by their owners were included in this study. Data were collected from the owners and referring veterinarians included history, signalment of the animals, physical examination, associating problems, and response to conservative treatment whenever applied.

History and signalment of the animals, which included address of the owner, animal breed, weight and age, nature of feeding, housing, if other animals suffering the same problem, dura-

tion of the problem, changes in the feeding stuff within the last 3 months, if the animal was reared up by the owner or was recently purchased from the market, any concomitant medical problem, number of parturitions (primiparous or pleuriparous), time of calf weaning, volume of milk produced (high or low, enough for its calf or not), nature of parturition of the last 2 times (eutocia or dystocia), time of first post-partum estrous, conception rate after 1st mating or artificial fertilization, and the preferred teat that was sucked by the animal.

Physical examination included recording of body temperature, heart rate, respiratory rate, color of mucous membrane, hydration status, ruminal cycle, gait and posture of animals (normal or abnormal), signs of depraved appetite, hypocalcemia or hypophosphatemia, presence of any external lesions (skin lesion, lameness), the status of the teeth especially the incisors, the character of papillae on the tongue surface (normal or long), and udder examination (normal, inflammation, teat injuries).

Thirty cows were not subjected to any treatment and their owners preferred either to sell or to slaughter their animals after being diagnosed as milk-suckers.

Animals (n=70) were then divided into 2 groups according to the treatment method. Forty cows in group (1) were treated conservatively by using milk-sucking preventer in the form of plastic nose or mouth rings. Thirty animals in group (2) (cows=20 and buffaloes=10) were surgically treated. Surgically operated animals were subjected to either ventral partial glossectomy (n=20; cows=14 and buffaloes=6) or inverting (tongue reshaping) technique (n=10; cows=6 and buffaloes=4).

The animal was sedated by intramuscular injection of 0.05mg/kg of Xylazine HCl 2% (Xyla-ject 2%; 1mL=20 mg, Adwia Co. S.A.E. 10th of Ramadan City, A.R.E). The animal was positioned in a right lateral recumbency with complete securing of the head and limbs. The mouth cavity was opened using a mouth gag. The tongue was grasped and a plastic tourniquet was applied at its base. It was washed several times using normal physiological saline (0.9% NaCl, Egypt Otsuka pharmaceutical Co. S.A.E. 10th of Ramadan City, Cairo, Egypt) and diluted solution of Povidone iodine (Povidone iodine 10%, Amoun Co. Egypt). Linear infiltration analgesia was performed using 10ml of Lidocaine HCl 2% (Debocaine 2%, Sigma-Tec Pharmaceutical Indust. Co.; packed by AL-Debeiky pharmaceutical industries Co., Egypt) at the ventral aspect of the tongue rostral to the tourniquet.

Ventral glossectomy technique was carried out according to Ducharme *et al.* (2017). The technique was performed on the ventral aspect of the tongue, while the dorsal surface was in contact with palm of the non-dominant hand of the surgeon provided that a three folded piece of sterile gauze was in between the surgeon's hand and tongue. The tip of the tongue was held using the tongue holding forceps by an assistant. A scalpel blade no. 22 was used for creating an elliptical incision 2cm rostral to the tourniquet and extended rostrally to about 2-3 cm of the tip of the tongue. The incision was about 3cm at its widest area and extended to about half the thickness through the lingual muscles. The wedge-shaped portion was then dissected and removed. The tongue defect was closed in two layers using Polyglycolic acid No. 2 (Egysorb; Taiser-Med SAE, Surgical sutures and meshes) and a round needle; continuous horizontal mattress sutures and a second layer of simple continuous suture pattern. The tourniquet was then removed and the tongue was massaged to avoid the accumulation of the blood that was formed in front of tourniquet and resulted from the excisional wound. The lavage of tongue was done several times using cold physiological saline and diluted solution of Povidone iodine.

The inverting (tongue reshaping) technique was carried out

according to El-Sherif (2018). A row of multiple interrupted vertical mattress suture pattern was applied using Polyglycolic acid No.2 and a round needle. The caudal stitch was in front of the tourniquet and the most rostral one was 3 cm apart from the tip of tongue. The stitches were applied perpendicular to the midline of the tongue and also did not penetrate the midline blood vessels.

Animals were kept for 7 days post-operation on soft green fodders to avoid the penetration of the stitches by the hard feed stuffs. Procaine penicillin (8mg/kg) and dihydrostreptomycin (10 mg/kg) as broad spectrum antibiotics (Pen & strep; Norbrook® Laboratories Limited, Newry, United Kingdom) and flunixin meglumine (2 mg/kg) as non-steroidal anti-inflammatory drug (Flunixin, Norbrook® Laboratories Limited, Newry, United Kingdom) were administered intramuscularly for 5 and 3 post-operative consecutive days, respectively. A 6-month follow-up period was considered after surgery to record complications or return to milk-sucking.

Evaluation criteria included recording of mean operation time (min±SE), cost, invasiveness, mean healing time (day±SE), efficacy in treatment of self-sucking/inter-sucking, and presence of post-operative complications.

RESULTS

Mean (±SE) ages of cows and buffaloes were 4.6 (±0.11) and 5.4 (±0.3) years, respectively. Mean (±SE) weights of cows and buffaloes were 380.8 (±9.25) and 392 (±31.4) kilograms, respectively. Cow breeds were balady or native (n=50), mixed (n=15), Simmental (n=10) and Herford (n=15). The ten buffaloes were of native breed.

The distribution of animals in different villages of Elkharga city, the nature of animals' feeding, numbers of animals that were raised and purchased by owners, associating lesions (mastitis and teat injuries) were recorded in Tables 1 and 2.

Appetite was good in 70 animals (cows=60 and buffaloes=10). However, 30 cows, among the animals that were raised by the peasants, had depraved appetite in which they ate ropes and rocks. The mean (±SE) daily milk yield in cows was 11.46 (±0.18) kilograms/day (range=8-15) and in buffaloes was 12.8 (±0.33) kilograms/day (range=12-14). Seventy five animals (cows=67 and buffaloes=8) gave their birth normally without human interference (eutokia), while the others (cows=23 and buffaloes=2) found difficulties at parturition (dystokia). Sixty cows showed signs of estrous cycle within 2 months after parturition. Fifteen animals took 3 months for displaying the signs of estrous, whereas 15 cows displayed their heat after treatment that was begun four months after parturition. Buffaloes expressed signs of estrous somewhat late compared to cows. It took 3 to 4 months after parturition, especially after they were treated by phosphorus containing products such as dibasic sodium phosphate. The conception rate in cows was 85.6% (n=77) after coming into the first estrous of parturition. The remaining cows (n=13) became pregnant after uterine infusion using 2% of Povidone iodine. In buffaloes, the conception rate reached 100%.

Based on case histories obtained from owners and the examination of the udder and its teats, it was determined that both fore teats were sucked in 20 animals, the left fore teat in 20 animals, and the right fore teat in 20 cows. Ten animals sucked their right rear teats, and the same number sucked their left rear teats. The remaining 10 cows sucked the 4 teats.

Clinical examination of the animals revealed that they were in good body condition. Mean (±SE) body score was 2.9 (±0.07) and 3.1 (±0.1) for cows and buffaloes, respectively. Mean rectal

Table 1. Distribution of milk-sucking (self-sucking and inter-sucking) cows (n=90) in the villages of Elkharga city with their nature of feeding and associated lesions.

	Elkharga city	Port Said	Nasr	Boulak	Khartoum	Algeria	Sanaa	Baghdad	Total
Number of animals	30	10	13	5	12	8	5	7	90
Type of feeding	Wheat bran Clover Hijaz Hay Cone-ration	Clover Hijaz Hay	Wheat bran Clover Hijaz Hay	Wheat bran Clover Hijaz	Clover Hijaz Hay Cone-ration	Hay Cone-ration	Clover Hijaz Cone-ration	Cone-ration Hay	
Reared animal	20	7	10	5	8	6	5	4	65
Purchased animals	10	3	3	-	4	2	-	3	25
Cases without external lesions	18	2	5	2	4	3	3	4	41
Mastitis cases	5	3	2	-	4	2	-	2	18
Teat injuries	7	5	6	3	4	3	2	1	31
Inter-sucking	6	4	3	2	4	3	5	3	30
Self-sucking cases	24	6	10	3	8	5	-	4	60

Table 2. Distribution of milk-sucking (self-sucking and inter-sucking) buffaloes (n=10) in the villages of Elkharga city with their nature of feeding and associated lesions.

	Nasr	Khartoum	Algeria	Baghdad	Total
Number of animals	2	3	2	3	10
Type of feeding	Wheat bran, Clover Hijaz, Hay	Clover Hijaz, Hay Cone-ration	Hay, Cone-ration	-	
Reared animal	2	3	2	3	10
Purchased animals	-	-	-	-	-
Cases without external lesions	1	1	2	1	5
Mastitis cases	1	1	-	1	3
Teat injuries	-	1	-	1	2
Inter-sucking	-	1	-	2	3
Self-sucking cases	2	2	2	1	7

temperature, heart rate and respiratory rate were 38.4 (±0.03) °C and 38.2 (±0.09) °C, 69.34 (±0.7) beat/min and 62.9 (±2.4) beat/min and 21.6 (±0.55) breath/min and 20.1 (±2.16) breath/min for cows and buffaloes, respectively.

The animals' hydration status was normal, which was clearly determined from the skin test, moistening of the muzzle and the position of eyes within the orbital cavity. The color of mucous membranes was rosy red, and the mean capillary refilling time was 2 seconds. All animals were in normal posture and gait. There were no musculoskeletal lesions, especially in the hind limbs that could be noticed at close observation of the animals' posture and gait.

During examination of the mouth cavities of admitted cows and buffaloes, loose incisors, diastasis dentium, and laterally deviated central incisors were found in thirty animals (cows=27 and buffaloes=3). The lingual papillae were long giving a rough surface causing drooling in fifteen cows.

There were minor skin lesions on ten cows that had previously complained lumpy skin disease. A total of 15 out of 30 cows suffering from depraved appetites had postpartum hypocalcemia, which were effectively treated. Four out of 10 buffaloes had suffered post-parturient hemoglobinuria, which was diagnosed as hypophosphatemia that was effectively treated.

According to the case history and the clinical examination the animals did not have changes in the udder except some lesions in the teats that were mentioned before.

As long as the nose or mouth rings didn't wear out or destroy when left for a long time, the conservative treatment for milk sucking was effective in preventing the sucking of milk. However, the animals return to sucking themselves or others after removing the rings which were fixed for a long time. Furthermore, the

spikes in the rings caused udder injuries to other animals when the cows intersucked.

The surgical outcomes of the ventral glossectomy technique were satisfactory. The technique achieved its goal by preventing the animals from self-sucking in all treated animals. There were two post-operative complications that were recorded. The first was the development of stitches infection on the ventral aspect of the tongue in four animals (3 buffaloes and 1 cow). These animals received 5 successive days of broad spectrum antibiotic oxytetracyclin 5% (5 mg/kg IM, once daily; Pharma Swede Co. Egypt) with good resolution. The second complication that was observed was the development of wounds at the tip of tongue. It developed in 2 cows, which were treated topically using 2% Povidone-iodine solution. The surgical findings of the reshaping technique of the tongue were: 1) the time of operation was shorter than that of the ventral glossectomy technique (6.3 ± 0.18 min versus 12.95 ± 0.33 min). The time of operation started from the using of scalpel for lingual resection in the ventral glossectomy technique or from the insertion of first stitch in the reshaping technique. 2) The reshaping technique consumed less suture material relative to the glossectomy technique. 3) A buffalo and three cows came into self-sucking again after parturition and were operated on for the second time using the ventral glossectomy technique.

DISCUSSION

The presented study recorded a number of 100 animals suffering from milk-sucking during a relatively short period. These animals were reared as solitary animals or in small groups in houses. The dam-calf relationship was good, and calves were suckling their mothers till the age of weaning (12 weeks). There-

fore, the number of recorded cases of milk-sucking was low compared to those recorded in animals reared in farms (Wagner *et al.*, 2012; Johnsen *et al.*, 2015). Consequently, other contributing factors may be considered as causes of milk-sucking in the recorded animals within this study.

Age of current animals was around 4 years in cows and 5 years in buffaloes, which was similar to other studies (El-sherif, 2018; Seddek *et al.*, 2019). This age is the 2nd or 3rd lactation season and is considered the preferred age for rearing by farmers in Egypt. These animals were in high lactating seasons with mean (\pm SE) milk production of 11.46 (\pm 0.18) kilograms/day (range=8-15) in cows and 12.8 (\pm 0.33) kilograms/day (range=12-14) in buffaloes.

The vast majority of the recorded animals of this study gave birth normally without human assistance with decreased incidence of metritis and mastitis. Some cases had dystokia with subsequent endometritis, which were managed according to Mido *et al.* (2016). Greater milk production in dairy cows, associated with increased energy demands and increased milking frequency, inhibits estrual expression (Stevenson *et al.*, 1997). Although animals were lactating, they had good body score; good body condition and 60% of them displayed the estrous signs normally with high fertility and conception rate. This means that these animals had balanced body energy. Good appetite resulted in good energy balance, which is the key to the timing of first postpartum ovulation in milked cows (Butler and Smith, 1989; Zurek *et al.*, 1995).

There were 19 animals (15 cows and 4 buffaloes) had suffered hypocalcemia and hypophosphatemia in the present study. These cases were confirmed by their prompt responses to medications designated for such diseased conditions. In addition, 40 animals showed delayed post-partum estrous cycle. These disorders might be predisposing factors for self-sucking and inter-sucking in animals. Similarly, results of previous studies had supported that energy deficiency is a possible cause of self-sucking (Schluter *et al.*, 1981; Berger, 1989). Moreover, decreases in serum levels of cobalt (Co), Manganese (Mn) and phosphorus (P) levels, which are important in carbohydrate and energy metabolism, had been proposed as likely causes of self-sucking (Greene *et al.*, 1985; Bademkiran *et al.*, 2008).

According to the results of the present work, animals can reach to any teat either in the self-sucking or inter-sucking. However, fore teats were preferred for sucking in about 60% in animals. It could be expected that the fore teats were self-sucked by animals, while the hind teats were sucked by other animals (inter-sucking) (Keil *et al.*, 2001; Lidfors and Isberg, 2003; Bademkiran *et al.*, 2007).

The proposed causes of milk-sucking in the present study could be cross-sucking, some minerals and trace elements deficiency in some animals, and the overcrowdings in the market. Milk-sucking (Inter-sucking/self-sucking) could be a continuation of cross-sucking, which is a behavior developed in calves and then turned to inter-sucking when they become heifers and finally became self-sucking in the present animals (Keil and Langhans 2001; Keil *et al.*, 2001). In the markets, the animals are overcrowded and close to each other, which may initiate inter-sucking.

Conservative treatment of milk sucking using nose or mouth rings is considered an easy, non-invasive, and transient way for management of milk-sucking in animals of the present study. The rings and their spikes hinder the cows' tongues to reach their own teats and the teats of other animals. However, it is not acceptable as a definitive treatment because animal returned to milk-sucking after missing or removing the device. Additionally, it caused injuries to cows whose udders were inter-sucked. This result is supported by the previous studies (Reinheckel, 1975; Von Deja *et al.*, 1982; Bademkiran *et al.* 2007). A recent published study discussed a novel successful, noninvasive, and conservative treatment of milk-sucking using tongue piercing technique (Salman *et al.*, 2022).

The previous studies discussed different surgical techniques for definitive treatment of the milk sucking in animals. All tech-

niques aimed to alter the tongue's contour to prevent the animal from cupping its tongue for sucking (Ducharme *et al.*, 2017). In the present study, the authors compared two surgical techniques. The ventral glossectomy is well established old technique (Tadmor and Ayalon 1972; McCormack, 1976) and recent tongue reshaping technique (El-Sherif, 2018). The first technique achieved satisfactory results for preventing of milk-sucking in all animals similar to results of another study (Abou-El-Ella, 1999). These results were consistent with the outcomes of a previous study (Hwan-Yul *et al.*, 2008). This surgery leads to narrowing of the tongue and scar formation, which prevent the animals from cupping of tongue to hold the teats during sucking (Abou-El-Ella, 1999). However, the present study recorded some complications such as stitches' infection and wounds at the tip of the tongue. These complications were recorded in 6 out of 20 operated animals. These complications could be iatrogenic in origin or due to the carelessness of the owners. Polyglycolic acid was currently used for closure of tongue's defect. The used suture material is multifilament, which could harbor infection especially if the aseptic measures had not been done completely. These complications disappeared within 5 days of using broad spectrum antibiotics.

Current results showed that tongue reshaping is a fast, non-invasive technique compared to ventral glossectomy technique. A result that was consistent with another study (El-Sherif, 2018). In the present study, four out of ten animals relapsed and returned to badly behave milk-sucking with success rate being 60%. This result was unlike the results of a previous study on only 5 cows with success rate being 100% (El-Sherif, 2018). The high percentage of failure of this technique in the present study might be attributed to the swelling of the tongue because of the multiple insertion of the needle and suture material in a highly vascularized muscular organ. This resulting swelling may be large enough to disrupt the stitches. The relapsed animals were currently treated with ventral glossectomy and completely recovered from milk-sucking. According to these results, although, ventral glossectomy consumed more time and suture materials with postoperative complications, it was more effective than tongue reshaping for treating milk-sucking in cows and buffaloes.

CONCLUSION

Cross-sucking in the calf-hood period, energy, and some mineral deficiency, and overcrowding in the markets might be the main causes of milk-sucking. Conservative treatment was effective as far as the device present in situ. Ventral glossectomy was better than tongue reshaping in treatment of the milk-sucking in cows and buffaloes.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

- Abou-El-Ella, A.G., 1999. Surgical treatment of anomalous milk sucking in Friesian dairy cattle. *Assiut Veterinary Medical Journal* 42, 260–270.
- Allmacher, G., 1998. Mouth-Nose ring to prevent cattle from sucking. *Deutsche tierärztliche Wochenschrift* 105, 104–105.
- Bademkiran, S., Celik, R., Yesilmen, S., Kanay, B.E., Kilinc, M., 2007. The effects of self-sucking on daily milk product, udder health and the form of the teats of dairy cows. *Journal of Animal and Veterinary Advances* 6, 1250–1254.
- Bademkiran, S., Üstün, B., Kanay, B.E., 2006. Application of some methods to prevent of self-sucking in dairy cattle in Diyarbakir Province. *YYÜ Vet Fak Derg*, 17, 59–64.
- Bademkiran, S., Yokus, B., Icen, H., Cakir, D.U., Kurt, D.O.Ğ.A.N., 2008. Assessment of serum mineral and certain biochemical variables in self-sucking dairy cows. *Journal of Animal and Veterinary Advances* 7, 717–722.
- Berger, G., 1989. Langja`hrige Beobachtungen zur Milchsaugerproblematik in einer groa`en Milchvieherde. (Long-term observations on

- the milk teat problem in a large herd of dairy cattle). *Mh. Veterinary Medicine* 44, 101–103.
- Butler, W.R., Smith, R.D., 1989. Interrelationships between energy balance and postpartum reproductive function in dairy cattle. *Journal of Dairy Science* 72, 767-783.
- Debreceni, O., Juhás, P., 1999. Milk-Sucking in dairy cattle in loose housing in Slovakia. *Livestock Production Science* 61, 1–6.
- Ducharme, N.G., Desrochers, A., Fubini, S.L., Pease, A.P., Mizer, L.A., Walker, W., Trent, A., Roy, P., Rousseau, M., Radcliffe, R., Steiner, A., 2017. Surgery of the bovine digestive system. In *Farm animal surgery*. (Fubini, S. and Ducharme, N.G. Editors). 2nd edition, Elsevier Inc. pp. 223-226.
- El-Sherif, M.W., 2018. Tongue reshaping: A new surgical method to prevent self-sucking in dairy cows. *Open Veterinary Journal* 8, 140–143.
- Greene, L.W., Harms, P.G., Schelling, G.T., Byers, F.M., Ellis, W.C., Kirk, D.J., 1985. Growth and estrous activity of rats fed adequate and deficient levels of phosphorus. *Journal of Nutrition* 115, 753-758.
- Hwan-Yul, Y., Jong-Ki, C., Sung-Ki, K., 2008. Tongue Surgery of a Dairy Cow Showing a Consistent Intersucking Behavior. *Journal of Veterinary Clinics* 25, 136-138.
- Jensen, M.B., Kyhn, R., 2000. Play behavior in group-housed dairy calves, the effect of space allowance. *Applied Animal Behavior Science* 67, 35–46.
- Johnsen, J.F., de Passille, A.M., Mejdell, C.M., Bøe, K.E., Grøndahl, A.M., Beaver, A., Rushen, J., Weary, D.M., 2015. The effect of nursing on the cow - Calf bond. *Applied Animal Behavior Science* 163, 50-57.
- Keil, N.M., Audigé, L., Langhans, W., 2001. Is intersucking in dairy cows the continuation of a habit developed in early life? *Journal of Dairy Science* 84, 140–146.
- Keil, N.M., Langhans, W., 2001. Development of intersucking among dairy calves around weaning. *Applied Animal Behavior Science* 72, 295-230.
- Lidfors, L., Isberg, L., 2003. Intersucking in dairy cattle-review and questionnaire. *Applied Animal Behavior Science* 80, 207–231.
- McCormack, J., 1976. Surgical procedure for prevention of self-sucking in cattle. *Veterinary Medicine: Small Animal Clinicians* 71, 681-683.
- Mido, S., Murata, N., Rawy, M.S., Kitahara, G., Osawa, T., 2016. Effects of intrauterine infusion of povidone-iodine on endometrial cytology and bacteriology in dairy cows with clinical endometritis. *Journal of Veterinary Medical Sciences* 78, 51-556.
- Reinheckel, D., 1975. Chirurgische Behandlung von milchsaugenden Kühen und Färsen. (Surgical treatment of milk-sucking cows and heifers). *Mh. Veterinary Medicine* 30, 97–99.
- Salman, Y., Semieka, M., Karmi, M., Al-lethie A., 2022. A novel surgical technique for prevention of self-sucking in cattle and buffaloes: tongue piercing. *BMC Veterinary Research* 18, 192-198.
- Schluter, H., Teuffert, J., Von Burmeister, F., 1981. Untersuchungen zum Saugverhalten, zur Häufigkeit und zu den Ursachen des Milchsaugens Massnahmen gegen das Milchsaugen der Rinder. (Investigations into the suckling behaviour, the frequency and the causes of milk sucking. Measures against milk sucking in cattle). *Mh. Veterinary Medicine* 36, 403–407.
- Seddek, A.M., Abdelfattah, M., Elrashidy, M.H., Mahmoud, F.A., Zakaib, F.A., 2019. Intra-lingual suture pattern for prevention of self-suckling in cows. *Veterinary and Animal Science* 8, 100062.
- Stevenson, J.S., Lamb, G.C., Hoffmann, D.P., Minton, J.E., 1997. Interrelationships of lactation and postpartum anovulation in suckled and milked cows. *Livestock Production Science* 50, 57-74.
- Tadmor A, Ayalon N., 1972. Surgical treatment of sucking in cows. *Refuah Veterinary* 29, 169-173.
- Von Deja, O., Partzsch, C., Vedder, H., 1982. Erste Erfahrungen beim Einsatz der Frohndorfer Methode gegen das Saugen der Rinder im Bezirk Erfurt. (First experiences with the use of the Frohndorf method against sucking cattle in the district of Erfurt). *Mh. Veterinary Medicine* 37, 132–134.
- Wagner, K., Barth, K., Palme, R., Futschik, A., Waiblinger, S., 2012. Integration into the dairy cow herd: Long-term effects of mother contact during the first twelve weeks of life. *Applied Animal Behavior Science* 141, 117-129.
- Zurek, E., Foxcroft, G.R., Kennelly, J.J., 1995. Metabolic status and interval to first ovulation in postpartum dairy cows. *Journal of Dairy Science* 78, 1909-1920.