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Minireview

MILK FLOW KINETICS IN TSIGAI AND IMPROVED VALACHIAN EWES AS AN IMPORTANT MILKABILITY TRAIT

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ABSTRACT

The aim of this review is to call attention to the possibility of the use of the evaluation of milk flow and morphological characteristics in ewes in relation to breeds. The recorded milk flow can be used to evaluate the milkability of ewes during machine milking. Moreover, the intensity of milk flow demonstrates the physiological reaction of dairy sheep to stimulation by machine milking. This reaction can be indicated by different total milk yield, too. It is possible to distinguish four basic types of milk flow: one peak (1P; removal of milk only from cistern), two peaks (2P; removal of milk from cistern and from alveoli in response to the milk ejection reflex), plateau I (PLI; milk flow patterns with steady milk flow during milking and maximal milk flow rate > 0.4 l/min) and plateau II (PLII; milk flow patterns with steady milk flow during milking and maximal milk flow rate ≤ 0.4 l/min). The highest total milk yield was measured in dairy sheep with PLI type of milk flow and the lowest with 1P type of milk flow. In breeds Tsigai, Improved Valachian and Lacaune all types of milk flows were observed, but with different percentages of the occurrence.

Key words: dairy sheep; milk flow kinetics; morphological characteristics

INTRODUCTION

Natural and climatic conditions of Slovakia are appropriate for sheep breeding. In Slovakia, Tsigai and Improved Valachian are the mostly bred sheeps belonging to autochthonous and locally adapted breeds.

Tsigai is one of the oldest black-headed breeds in Slovakia, reared mainly in the Central and East Slovakian regions at an altitude from 500 to 800 m. The animals are of a middle body frame, with a black head and legs and with good adaptability to seasonal open-air rearing. Typical Tsigai variants probably represent remnants of similar types of sheep which once populated the ancient Asia Minor, from where most domestic sheep breeds originate. From the beginning of the 19th century, exotic breeding stocks were also commonly introduced, to improve productivity, depending on the preferred breeding objectives (wool, milk, meat).

The breed Improved Valachian originated from coarse wool Valachian breed in Slovakia, where intensive cross-breeding programme started in 1950. To improve wool, meat and milk production the crossing with wide range of breeds (Leicester, Lincoln, Texel, Cheviot, Kent and East Friesian sheep) was attempted. The Improved Valachian was recognized as an independent dual-purpose breed (wool-meat and meat-milk, respectively) in 1982.

Tsigai and Improved Valachian are very similar in production potential. At present Tsigai and Improved Valachian are crossed with the purpose to improve their milk production, milkability and prolificacy with dairy breeds as Lacaune and East Friesian (Capistrak et al., 2001; Margetín et al., 2005a).

In last decades, the number of farms with machine milking or interest to milk the sheep with machine has increased. This fact evokes the question whether

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the breeds kept in Slovakia are suitable for machine milking. This can be found by evaluation of the milking characteristics and udder morphology. These traits are one of the factors determining milkability in dairy ewes (Dzidic et al., 2004). Knowledge of milk yield, milking time and udder conformation is useful for optimization of the milking routine and milking machine parameters to needs of the ewes. Milkability can be evaluated by analysis of the milk flow curves (Labussière, 1988; Mayer et al., 1989; Bruckmaier et al., 1997; Caja et al., 2000) and udder morphology measurements (Labussière, 1988; Fernández et al., 1995; Milerski et al., 2006). Moreover, machine milkability can also be estimated by fraction of milking - machine milking, machine stripping, and residual milk (Such et al., 1999).

Milk flow

Milk flow is one of the most interesting criteria for studying milkability in the machine milking of dairy ewes and its main traits are considered to be relevant for design of milking machines and to adapt the optimal milking routine in each breed (Caja et al., 2000). The dairy ewes with the ideal milk flow are quick and complete milking, with a high milk flow rate and an effective ejection of alveolar milk (Bruckmaier et al., 1997; Marnet et al., 1998). The milk flow is related to udder morphology (cistern depth), teat (position, size) and neuro-hormonal reaction of the dairy ewes on machine milking (Labussière, 1988; Bruckmaier et al., 1997; Marnet et al., 1998).

The milk flow curves can be one peak (1P), two peaks (2P), plateau I (PLI) and plateau II (PLII; Fig. 1). 1P milk flow curve could represent milk flow without alveolar milk ejection and only cisternal milk fraction is removed in response to machine milking. On the other hand, the milk flow curves with two separated peaks (2P) show alveolar milk ejection after the cisternal milk is removed. PLI milk flow curve refers to ewes with larger emission curve and did not show clear differences between peaks (Labussière, 1988; Rovai et al., 2002; Marnet et al., 1998). Ewes with PLII also have the steady milk flow, but at low rate. It is supposed that the ewes with PLII type of milk flow have extremely weak or totally absent oxytocin release during milking (Bruckmaier et al., 1997).

An efficient milk ejection reflex (2P ewes) is still of primordial importance and helps to explain the adaptation to machine milking in small ruminants (Marnet et al., 2001). With genetic selection for high milk yield associated with well-adapted ewe to milking, the second peak is sometimes not visible. The second peak is masked because at the time of milk ejection, the cisternal fraction has not completely removed from the udder when the alveolar fraction descends into cistern for removal (Marnet et al., 1998). However, not only due to higher milk production but also due to decreased average milk flow rate, the second peak can not be distinguished.

The results of occurrence of single milk flow types and the time of ejection reflex could be aided by the evaluation of the labour input during machine milking with regards on welfare of ewes during milking (Mačuhová et al., 2010). The occurrence frequency of milk flow types could be also impacted by breeding conditions and breeding performance.

The occurrence frequency of different milk flow patterns (1P : 2P : PLI : PLII) was 43 : 50 : 7 : 0 % for Tsigai, 30.5 : 39 : 30.5 : 0 % for Tsigai x Lacaune cross, 10.5 : 42 : 37 : 10.5 % for Lacaune, 47 : 47 : 6 : 0 % for Improved Valachian, 0: 67 : 22 : 11 % for Improved Valachian x Lacaune cross. This would mean that more than 50 % of all tested breeds and crossbreed ewes showed clear ejection reflex during the machine milking (Mačuhová et al., 2008). Marnet et al. (1998) observed that 56 % ewes with two separate peaks for Lacaune breed in France, which is only 42% in our conditions (Mačuhová; 2008). In the breed Lacaune in Spain, 5 % animals were found to be with 1P, 60 % with 2P and 35 % with PLI type of milk flow. In Manchega breed (for meat-milk purpose), occurrence of milk flow types showed lower clear ejection reflex during the machine milking than in Lacaune (75 % vs. 66 % with 2P, respectively). Twenty-five percent animals of Manchega breed had 1P milk flow type (Rovai et al., 2002). Crossing with Lacaune influenced milk flow of crossbred ewes. They had higher occurrence of PLI due to higher milk yield of crossbreed ewes than purebred Tsigai and Improved Valachian animals (Mačuhová et al., 2007, 2008). The milking time of breeds could be influenced by occurrence frequency of particular type of milk flow (Mačuhová et al., 2008).

In the breeds Tsigai, Improved Valachian and Lacaune tested in our studies the ewes with PLI type of milk flow had the highest total milk yield and milk yield followed by ewes with 2P type and the lowest in 1P (Mačuhová et al., 2007, 2008). The same effect was observed also in Manchega and Lacaune ewes (Rovai et al., 2002). The percentage of milk removed during machine stripping was the lowest in ewes with PLI followed by ewes with 2P and 1P type of milk flow (Mačuhová et al., 2007, 2008).

Percentage of milk yield of first emission (amount of milk obtained by first peak = cisternal milk) during milking with type of milk flow 2P was 81.43, 69.28 and 47.15 in Lacaune, Tsigai and Improved Valachian breeds, respectively. These results show that Lacaune and Tsigai with 2P had stored most of milk obtained by machine milking in cistern whereas Improved Valachian in alveolar spaces before milking (Mačuhová et al., 2008). Rovai et al. (2008) observed lower percentages of cisternal milk (77 %) in Lacaune dairy breed than it was observed in our conditions. In Sarda ewes, it was 82 % (Nudda et al., 2000) and in Manchega ewes 59 % (Rovai et al., 2008). These results show that percentage of milk yield of first emission can vary not only between breeds, but also between animals of the same breed bred in different conditions.

The crossing of different breeds is often used to improve required characteristics. Positive effect of crossing Tsigai and Improved Valachian with Lacaune was proved by cistern depth. The crossbreed animals had more than 73 % of milk from machine milk yield stored in cistern before milk ejection occurred (Mačuhová et al., 2008). Cistern size is related to autocrine inhibition of milk secretion in mammary gland. Animals with large cistern are more efficient producers of milk and more tolerant to long milking intervals in general (Wilde and Peaker, 1990). According to Rovai et al. (2008) cistern size is a limiting factor for milk production in dairy ewes. Its role seems to be more important than the amount of secretory tissue under the milking conditions and sheep breeds used.

The beginning of bimodality (the start of alveolar milk emission) range in purebred breeds Tsigai, Improved Valachian and Lacaune from 40 to 47 s and in crossbreed Tsigai and Improved Valachian with Lacaune (50 % : 50%) from 34 to 44 s (Mačuhová et al., 2007, 2008). Estimated values of beginning of bimodality in previous studies were between 40th and 50th s of milking (Margetín et al., 2005b). The time of beginning of bimodality did not need to be constant. In cows, the time of milk ejection depends on degree of udder filling (Bruckmaier and Hilger, 2001). Moreover, the percentage of ewes presenting the ejection reflex decreased throughout lactation (Rovai et al., 2002). This has also been demonstrated in the breeds Lacaune, Tsigai and Improved Valachian when occurrence of 2P type of milk flow decreased and 1P increased during lactation (Tančin et al., 2009). In later stage of lactation, the differences were stronger (Tančin et al., 2009). The ewes with stabile milk flow represented 69 %. The highest stability was seen in ewes with 1P milk flow type (100 %; Tančin et al., 2009). The frequency of milk flow type curve varied according to the parity number, showing an increase in ejection reflex with age (Rovai et al., 2002).

Morphological properties of the udder and correlations

The removal of milk during milking can be affected also by morphology of the udder. The udder morphology might be influenced by several factors, such as genotype, lactation number, lactation stage and breeding system

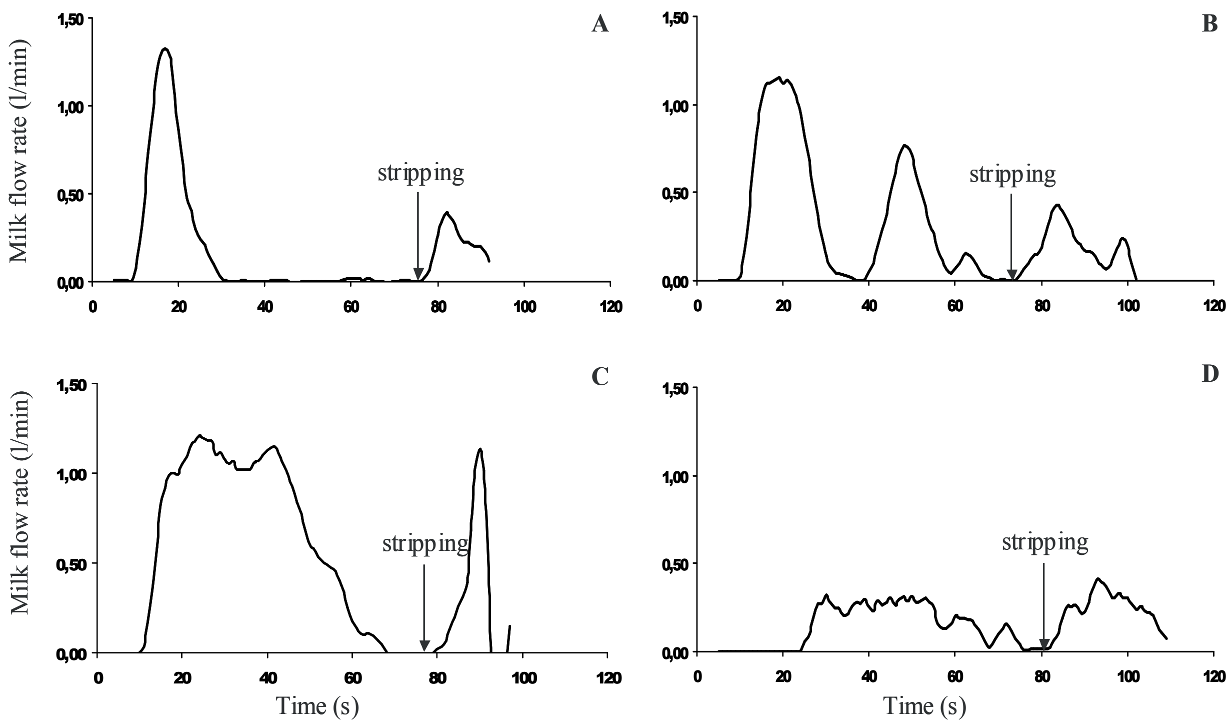

Fig. 1: Different milk flow patterns during machine milking of breeds Tsigai, Improved Valachian, Lacaune, Tsigai x Lacaune, Improved Valachian x Lacaune. (A): 1 peak; (B): 2 peaks, (C) plateau I, (D) plateau II

(Apolen et al., 2000; Čapistrák et al., 1997; Milerski et al., 2006). Lacaune had more horizontally positioned teats than purebred breeds Tsigai and Improved Valachian (Mačuhová et al., 2008; Apolen et al., 2000). The same results were observed also by Milerski et al. (2006). The crossing with Lacaune can negatively influence the teat position in Tsigai x Lacaune (6.0 points in crossbreds, 4.5 in purebreds) and Improved Valachian x Lacaune (5.3 points in crossbreds, 4.9 in purebreds; Mačuhová et al., 2008). This should be taken into consideration for future breeding programmes. The positive effect of crossing was observed in area of cisterns when Improved Valachian x Lacaune had about 32 % larger area of cistern than Improved Valachian ewes (Margetín et al., 2002). However, ewes with deeper cisterns (i.e. more udder volume below the teat canal exit) take longer to milk than ewes with shallower cisterns. It is not surprising because ewes with taller cisterns produce more milk (McKusick, 2000).

Total milk yield and machine milk yield were significantly correlated with maximal milk flow rate, milking time, cistern depth, teat angle, teat position but not with machine stripping and milk flow latency (i.e. time when milk flow started after claw attachment). Milk flow latency showed positive correlations with milking time and negative correlations with maximal milk flow rate (Mačuhová et al., 2008). The positive and significant correlation between milk yield and milk flow rate suggests that high producing animals have fast milk removal (Dzidic et al., 2004). The positive and significant correlation was found also between teat position and cistern depth (points) in Tsigai, Improved Valachian and Lacaune breeds (Milerski et al., 2006; Mačuhová et al., 2008). It means that ewes with deeper cistern had more horizontally positioned teats. The same effect was also observed between teat angle and cistern depth when these udder traits were measured (Milerski et al., 2006; Mačuhová et al., 2008) and also in Manchega (Rovai et al., 1999) and East Friesian ewes (McKusick et al., 2000). The latest mentioned authors used an opposite scale for teat position evaluation; therefore, the correlation was negative. However, the udders with deeper cisterns and bigger teat angle can have problem with falling off the cups during milking (Labussière, 1988) and increasing of stripping milk yield by a part of the cisternal milk which is located below the orifice into the teat canal and cannot be reached without machine stripping (Bruckmaier et al., 1997). This can prolong the milking time and thereby reduce the efficiency of machine milking. The average udder size of Lacaune ewes was larger than in Improved Valachian and Tsigai breeds (Milerski et al., 2006). The larger cistern of Lacaune ewes and their low proportion of residual milk help this breed to tolerate the extremely simplified milking method. Moreover, they have predisposed to adapt to long intervals between milking (Labussière, 1988). These ewes have more storage volume which is one of the components which keeps intra-mammary pressures low and more easily avoids over-distention of the alveoli between milkings (McKusick, 2000). Improved Valachian and Tsigai ewes do not belong to really high producing ewes, however, already in these sheeps positive correlations of total milk yield with cisternal depth and position of teat could be observed (Mačuhová et al., 2008). This could indicate that further breeding for higher milk production could lead to worsening of udder morphology (as it is observed in high producing ewes in other studies).

CONCLUSION

Milk flow parameters depend on many factors like breed, stage of lactation and time of milking. Individual parameters of milk flow are used in many countries to evaluate the milkability of herd as well of individual ewes. Morphological udder traits are closely related to milk production and milk flow characteristics. Therefore, these parameters should be used in selection of animals, designing of linear scoring schemes and in crossing programmes of single breeds.

REFERENCES

APOLEN, D. – ČAPISTRÁK, A. – MARGETÍN, M. – ŠPÁNIK, J. 2000. Relation between udder shape and milk production in sheep. *J. Farm. Anim. Sci*., vol. 33, 2000, p. 223-228. [in Slovak]

BRUCKMAIER, R. M. – HILGER, M. 2001. Milk ejection in dairy cows at different degrees of udder filling. *J. Dairy Res*., vol. 68, 2001, p. 369-376.

BRUCKMAIER, R. M. – PAUL, G. – MAYER, H. – SCHAMS, D. 1997. Machine milking of Ostfriesian and Lacaune dairy sheep: udder anatomy, milk ejection, and milking characteristics. *J. Dairy Res*., vol. 64, 1997, p. 163-172.

CAJA, G. – SUCH, X. – ROVAI, M. 2000. Udder morphology and machine milking ability in dairy sheep. In: Proceedings of the 6th Great Lakes Dairy Sheep Symposium November 2-4, 2000. Guelph, Ontario, Canada. p. 17-40.

CAPISTRAK, A. – MARGETIN, M. – APOLEN, D. – SPANIK, J. 2001. Milk production and prolificacy of purebred Tsigai and Improved Valachian sheep and their crosses with Lacaune breed. In: Book of abstract of the 52nd annual meeting of the European association for animal production, Budapest, Hungary, 26 – 29 August 2001, p. 264. ISBN 9076998019

ČAPISTRÁK, A. – MARGETÍN, M. – ŠPÁNIK, J. – BACHYNCOVÁ, T. 1997. Milk production and morphological properties of udder in sheep of Tsigai breed and their crosses with Suffolk breed. *J. Farm. Anim. Sci*., vol. 30, 1997, p. 110-118. [in Slovak]

DZIDIC, A. – KAPS, M. – BRUCKMAIER, R. M. 2004. Machine milking of Istrian dairy crossbreed ewes: udder morphology and milking characteristics. *Small Rum. Res*.,

vol. 55, 2004, p. 183-189.
FERNÁNDEZ, G. – ALLVAREZ, P. – SAN PRIMITIVO, F. – DE LA FUENTE, L. F. 1995. Factors affecting variations of udder traits of dairy ewes. *J. Dairy Sci.,* vol. 78, 1995, p. 842-849.
LABUSSIÈRE, J. 1988. Review of physiological and anatomical factors influencing the milking ability of ewes and the organization of milking. *Livest. Prod. Sci*., vol. 18, 1988, p. 253-274.
MAČUHOVÁ, L. – MAČUHOVÁ, J. – UHRINČAŤ, M. – TANČINOVÁ, D. – TANČIN, V. 2010. Labour input during machine milking and welfare of ewes. *Potravinárstvo*, vol. 4, 2010, p. 179-188. [in Slovak]
MAČUHOVÁ, L. – UHRINČAŤ, M. – MAČUHOVÁ, J. – MARGETÍN, M. – TANČIN, V. 2008. The first observation of milkability of the sheep breeds Tsigai, Improved Valachian and their crosses with Lacaune. *Czech J. Anim. Sci*., vol. 53, 2008, p. 528-536.
MAČUHOVÁ, L. – UHRINČAŤ, M. – MARNET, P. G. – MARGETÍN, M. – MIHINA, Š. – MAČUHOVÁ, J. – TANČIN, V. 2007. Response of ewes to machine milking: evaluation of the milk flow curves. *Slovak J Anim. Sci.*, vol.40, 2007, p. 89-96. [in Slovak]
MARGETÍN, M. – MILERSKI, M. – APOLEN, D. – ČAPISTRÁK, A. – ORAVCOVÁ, M. 2005a. Morphology of udder and milkability of ewes of Tsigai, Improved Valachian, Lacaune breeds and their crosses. In: Physiological and technical aspect of machine milking. Nitra, Slovak Republic, 2005, p. 259-263.
MARGETÍN, M. – MILERSKI, M. – APOLEN, D. – ČAPISTRÁK, A. – ŠPÁNIK, J. 2005b. Milk ejection in ewes during first 60 seconds of machine milking. *J. Farm. Anim. Sci*., vol. 38, 2005, p. 201 – 210. [in Slovak]
MARGETÍN, M. – MILERSKI, M. – APOLEN, D. – ČAPISTRÁK, A. – ŠPÁNIK, J. – MARGETÍNOVÁ, J. 2002. Mammary cistern size of dairy ewes determined by ultrasound techniques. *J. Farm. Anim. Sci*., vol. 35, 2002, p. 97-105. [in Slovak]
MARNET, P. G. – NEGRAO, J. A. – Labussière, J. 1998. Oxytocin release and milk ejection parameters during milking of dairy ewes in and out of natural season of lactation. *Small Rum. Res*., 1998, vol. 28, p. 183-191.
MARNET, P. G. – MCKUSICK, B. C. 2001. Regulation of milk ejection and milkability in small ruminants. *Livest. Prod. Sci*., vol. 70, 2001, p. 125-133.
MAYER, H. – WEBER, F. – SEGESSEMANN, V. 1989. A method to record and define milk flow curves of ewe during routine machine milking. In: Proceedings 4th International Symposium on Machine Milking of Small Ruminants, Tel Aviv, Israel, September 13.–19. 1989, p. 564–573.
MCKUSICK, B. C. 2000. Physiologic factors that modify the efficiency of machine milking in dairy ewes. In: Proceedings 6th Great Lakes Dairy Sheep Symposium, Dept. November 2.-4. 2000, Guelph, Ontario, Canada, p. 86-100.
MCKUSICK, B. C. – MARNET, P. G. – BERGER, Y. M. – THOMAS, D. L. 2000. Preliminary observations on milk flow and udder morphology traits of East Friesian crossbred dairy ewes. In: Proceedings 6th Great Lakes Dairy Sheep Symposium, Dept. November 2.-4. 2000, Guelph, Ontario, Canada, p. 101-116.
MILERSKI, M. – MARGETÍN, M. – ČAPISTRÁK, A. – APOLEN, D. – ŠPÁNIK, J. – ORAVCOVÁ, M. 2006. Relationships between external and internal udder measurements and the linear scores for udder morphology traits in dairy sheep. *Czech J. Anim. Sci*., vol. 51, 2006, p. 383-390.
NUDDA, A. – PULINA, G. – VALLEBELLA, R. – BENCINI, R. – ENNE, G. 2000. Ultrasound technique for measuring mammary cistern size of dairy ewes. *J. Dairy Res.,* vol. 67, 2000, p. 101-106.
ROVAI, M. – CAJA, G. – SUCH, X. 2008. Evaluation of udder cisterns and effects on milk yield of dairy ewes. *J. Dairy Sci*., vol. 91, 2008, p. 4622-4629.
ROVAI, M. – SUCH, X. – CAJA, G. – PIEDRAFITA, J. 2002. Milk emission during machine milking in dairy sheep. *J Dairy Sci*. 80 (Suppl. 1):5(Abstr.), 2002, p. 58.
ROVAI, M. – SUCH, X. – PIEDRAFITA, J. – CAJA, G. – PUJOL, M. R. 1999. Evaluation of morphology traits during lactation and its relationship with milk yield of Manchega and Lacaune dairy sheep. In: *Milking and milk production of dairy sheep and goat.* F. Barillet and N.P. Zervas, EAAP Publication No. 95, Wageningen pers., Wageningen, The Netherlands, 1999, p. 107-109. ISBN 90-74134-64-5
SUCH, X. – CAJA, G. – PEREZ, L. 1999. Comparison of milkability between Manchega and Lacaune dairy ewes. In: Milking and milk production of dairy sheep and goat. F. Barillet and N.P. Zervas, EAAP Publication No.95, Wageningen pers. : Wageningen, The Netherlands, 1999, p. 45-50. ISBN 90-74134-64-5
TANČIN, V. – MAČUHOVÁ, L. – KOVÁČIK, J. – KULINOVÁ, K. – UHRINČAŤ, M. Stability of milk flow kinetics in sheep during machine milking, *Slovak J. Anim. Sci*., vol. 42, Suppl. 1, 2009, p. 110-114.
WILDE, C. J. – PEAKER, M. 1990. Autocrine control in milk secretion. *J. Agr. Sci*., vol. 114, p. 235-238.