Journal of International Scientific Publications:
Agriculture & Food, Volume 1, Part 1
ISSN 1314-8591 , Published at: http://www.scientific-publications.net

GROWTH INTENSITY OF FEMALE CALVES DEPENDING ON THE MILK FEEDING TECHNOLOGY

L. Degola and A. Karps
Institute of Agrobiotechnology, Latvia University of Agriculture, Liela street 2, Jelgava, Latvia

Abstract

The goal of research was to estimate growth intensity of female calves depending on the milk feeding technology. The trial carried out in Latvia with 14 to 104 days old calves one Holstein breed sires 26 daughters, who were divide into 2 equal groups of 13 animals each. Individual cages held calves were fed milk (individual group – IG) from the buckets 2 times a day (by 2.5 kg milk), but free group held calves (automatic group – AG) of milk machine during small portions (by 300g) all day. The calf feeding milk substitute was used, the amount was limited, depending on the age of calves. During the trial, were accounted the consumption of feed and individual calves live weight each month, calculated daily weight gain and animal growth rate intensity. The results were processed with MS Excel statistical data processing program.The trial results showed that AG calves live weight at the end of the study, was significantly higher ($p < 0.05$) than the IG calves, respectively, 99.3 ± 2.28 and 93.8 ± 1.55 kg. The live weight gain per day differ significantly between groups ($p < 0.05$), and were higher for AG calves, in the trial periods of the 44 – 74 and 74 -104 days, but from 14 – 44 days was no difference. The calves had the highest growth rate intensity during the period of 14 – 44 days in both groups. The significant differences in growth rate intensity of calves ($p < 0.05$) between the IG and AG group was only during the period from 44 – 74 days.

This investigation showed that the higher growth rates intensity showed AG group calves at equal feed after 44 days age, but till this age the milk feeding technology did not significantly influence calves growth.

Key words: *cow, female calf, milk feeding technology, live weight gain, growth.*

INTRODUCTION

Rearing the female calf is one of the most challenging tasks on the dairy farm. With regard to female calves, the main objective is to rear a healthy calf to optimium mating weight (Kennedy, *et.al*., 2011) that will achieve optimium milk production in subsequent lactations. Since feed and labour are the two major inputs of calf rearing, it is important to establish the effect of alternative aspects on calf performance. The calf feeding methods can influence labour input and calf performance (Gleeson, *et.al*., 2008). Necessary to take particular care to feeding of female calf, supplied with high-quality feeds because they are dairy herds future. The correct nutrition dairy calves during the milk period is the complicate and responsible process. In recent years, research is connected with new feeding schemes, involving a different industrially manufactured, calves mature milk substitutes and the concentrated feed supplements. The influence of these feeds been studied to functional development of calves digestive system, as well as the body's growth and development (Ahmed *et.al*., 2005, Constable, *et al*., 2005, Daniel *et.al*., 2008, Hepol, *et.al* ., 2008, Hessle, *et.al*., 2004, Gleeson & O'Brein, 2012). The studies underlined that the milk is almost the only feed of calves in the first month of life, and its share up 90-95% of the energy value of the feed, the second month 60-65% and third 30-35% (Jemeļjanovs, 2001), mentioned that the length of milk feeding period and the dose can be reduced by replacing it with milk

replacer or special concentrated mixed feed called the starter and the pointing out that animal may not feel lack of nutrients and energy (Hepol, *et.al*., 2008, Quigley *et.al*., 2000). Some studies suggest that at the beginning of milk feeding calves in the abomasum increased gastric juice activity, which significantly increases the abomasal emptying time after the animal feeding and recommends that calves feed with milk at least 3 times a day (Birģele & Ilgažs, 2008).

The feeding of cold milk to calves once daily offers the opportunity for milk feeding to be carried out at an off-peak time during the working day. No difference in calf weight gain was observed when calves were individually fed cold milk replacer (room temperature) compared to warm milk (38°C) (Fallon & Harte, 1974). Feeding cold milk to calves has also been shown to increase concentrate intake and reduce milk intake (Fallon, 1998). In addition group feeding of calves once a day with cold whole milk indoors has been shown not to have any adverse affect on calf performance (Gleeson, *et.al*.,2007,2012). Furthermore, the labour requirement for calf care may be reduced if calves are grouped rather than reared in individual pens (Kung, 1997). The grouping of calves has also been shown to have advantages in terms of weight gain after weaning over those fed individually (Chua, *et.al*.,2001). Rearing calves outdoor appears to have benefits in terms of performance, labour and disease. The researchers found no difference in growth rates of calves reared outdoors in hutches compared to calves reared indoors in individual pens. They further suggested that a lower labour input was associated with the outdoor system. Calves can adapt to outdoor temperatures if a draft free area and dry bed is provided with adequate feed (Davis, *et.al.*,1998). A lower incidence of respiratory cases could be expected for calves reared outdoors as compared to those reared indoors (Earley,*et.al.*, 2004). With an increase in the value of whole milk, there is also a renewed interest in the feeding of milk replacer. In other research (Randall & Swannack, 1975) was demonstrated no differences between feeding of cold milk replacer compared to warm milk replacer. Calf performance was not affected by feeding milk replacer once daily in individual pens (Williams, 1986). Most studies on once daily calf feeding have investigated the effect of feeding milk replacer to calves individually. There is limited knowledge on feeding milk replacer to calves as a group combined with early turnout on calf performance.

The goal of our research was to estimate growth intensity of female calves depending on the milk feeding technology.

MATERIAL AND METHODS

The trial carried out in Latvia with 14 to 104 days old calves one Holstein breed sires 26 daughters, who were divided into 2 equal groups of 13 animals each. The trial lasted 3 months (Table 1). Individual cages held calves were fed milk (individual group – IG) from the buckets 2 times a day (by 2.5 kg milk at start of trial and 2.0 kg at the end of trial), but free group held calves (automatic group – AG) of milk machine during small portions (by 300g) all day over trial. The calf feeding milk substitute was used, the amount was limited, depending on the age of calves. Milk substitute consisted of whey powder, palm and coconut oils, soy protein concentrate, wheat gluten, yeast and calcium butyrate and contained crude protein (CP) 22%, crude fiber (CF) 0.4%, fat (F) 16%, ash 9.0%, lactose 41%, calcium (Ca) 0.9% and phosphorus (P) 0.6% of dry matter (DM). The milk substitute was of full value because contained also different microelements such as ferrum (Fe), cuprum (Cu), jodium (J), manganese (Mn), cink (Zn), selenium(Se) and vitamins (A, D_3, E, C).

The milk mixture was prepared in warm water for proportion 1: 7 which watered to calves according to the scheduled quantities till to 104 days of age (Table 1).

Table1. Calf feeding scheme (daily per one animal)

Indices	From 14 till 44 days of age		From 44 till 74 days of age		From 74 till 104 days of age	
	Milk, kg	Concentrate, kg	Milk, kg	Concentrate, kg	Milk, kg	Concentrate, kg
Individual group (IG)	5.0	0.6	5.0	1.0	4.0	1.5
Automatic group (AG)	5.0	0.6	5.0	1.0	4.0	1.5

During the trial, for calves were fed also a full value concentrated mixed feed, which consisted of milled barley (25%) and wheat (45%), soybean cake (26.5%) and mineral feed – Complette Keragen Longlife (3.5%). The content of concentrate feed was such: CP 22%, CF 7.5%, F 5.5%, ash 6.5%, Ca 1.2% and P 0.6%. This feed the calves to 14 days of age received ad libitum, but later the strictly limited. The both research groups according of the animals age received concentrated mixed feed from 0.6 - 1.5 kg per day (Table 1.)

Continuously, the calves had access to drinking water provided by the automatic drinkers and licked salt with mineralelements (KNZ). The hay were fed ad libitum according the animal's needs.

Diets and ingredients were analysed for dry matter forage analyses (DM USA, met. 2.2.1.1:1993), crude protein (CP LVS EN ISO 5983-2:2009), crude fiber (CF LVS EN ISO5498:1981), crude fat (F LVS EN ISO6492:1999), calcium (Ca LVS EN ISO6490/2:1983), phosphorus (P LVS EN ISO6491:1998) and energy for maintenance was calculated (ME LVS EN ISO13906:2008).

The individual group (IG) calves had raised in individual cages, but automatic group (AG) was kept in group together in the pen with automatic feeding. The groups of calves kept indoors. The microclimate was a same for both group.

The calves were weighted each trial month and calculated live weight gain by formula (1).

$$(1)\quad A = \frac{Wt - Wo}{t},$$

where A – liveweight gain per day, g;

t – period of trial, days;

Wt – liveweight at the beginnig of month, kg;

Wo – liveweight at the end of month, kg;

The animal growth rate intensity was calculated by formula (2).

$$(2)\quad R = \frac{Wt - Wo}{(Wo + Wt) \times 0.5 \times t} \times 100,$$

where R – growth rates intensity, %;

t – period of trial, days;

Wt – liveweight at the beginnig of month, kg;

Wo – liveweight at the end of month, kg;

During the trial was accounted the consumption of feed. Efficiency the consumtion of feed was computed over the trial period and calculated to one kg liveweight gain at the end of trial in dry matter.The results were processed with MS Excel statistical data processing program. The results were compared using t-test.

RESULTS AND DISCUSSION

The provided a different ration for each age period, are best kind to ensure the necessary nutrients for calves.

Table 2. Feed nutrients supply for one calf per day

Indices	Trial periods								
	From 14 till 44 days of age			From 44 till 74 days of age			From 74 till 104 days of age		
	Total	Require ments	+ or –	Total	Require ments	+ or –	Total	Require ments	+ or –
DM, kg	0.95	0.9	+ 0.05	1.64	1.50	+ 0.14	2.20	2.20	– 0.10
ME, MJ	23.3	23.0	+ 0.3	27.7	27.0	+ 0.7	32.98	31.0	+ 1.98
CP, g	280.2	280.0	+ 0.2	381.2	380.0	+ 1.2	452.2	440.0	+ 12.2
CF, g	79.7	80.0	– 0.3	210.0	220.0	– 10.0	430.0	450.0	– 20.0
F, g	187.0	190.0	– 3.0	190.4	195.0	– 4.6	189.1	200.0	– 10.9
Ca, g	13.21	13.0	+ 0.21	18.5	18.0	+ 0.5	23.4	23.0	+ 0.4
P, g	9.56	9.0	+ 0.56	12.4	12.0	+ 0.4	15.2	15.0	+ 0.2

For female calves are very important in order the all nutrients should be balanced by the needs of animals. In the trial the feedstuffs provided animals with nutrients according to their needs, except crude fiber and fat. These nutrients were less than are the requirements of the animals, but the difference was not greater than 5% (Table 2).

The different feedstuffs and calf feeding technology affects calf growth and development. The research about ad libitum milk intake was showed that ad libitum nipple feeding of milk to dairy calves can allow for increased milk intake and weight gain with no detrimental effects on intake of solid feed after weaning (Jasper &Weary, 2002). The calves of AG group had better growth rates (Table3).

The results showed that AG calves live weight at the end of the study, was significantly higher ($p < 0.05$) than the IG calves, respectively, 99.3 ± 2.28 and 93.8 ± 1.55 kg. The live weight gain differ significantly between groups ($p < 0.05$), and were higher for AG calves, in the trial period of the 44 – 74 and 74 -104 days, but from 14 – 44 days was no difference (Table 3).

All periods calves live weight was higher in AG group, which may be explained by the fact that the calves received feed free and so much more to satisfy your hunger, but no more than IG group calves. Feed better utilization driven by the fact that it is taken in small portions and richly mixed with saliva, which contributes to its complete processing calf digestive tract. Calves liveweights compared with average data on age-appropriate live weight in Latvia, it can be concluded that the trial calves up to 2

months of age in both groups of these indices have reached or even exceeded, that indicate to the groups apropriate and adequate feed. But the age of 3 months trial groups did not reached the desired live weight of calves. The calves which are drop back in the growth and development can lead to the risk that 13 to 15 months of age will not be in such condition if be able to start breeding. Although nutrients were provided, but the calves weight gains per day during the study was lower than in other scientific studies. The trial included daily live weight gains of calves ranged from 501 to 719 g d-1 (Fig. 1). In other studies in Latvia (Eihvalde & Kairisa, 2011) average daily weight gains of calves from birth to 3 months of age were from 581 to 831 g d-1. Compared to the IG and AG group liveweight gains per day of calves, significant differences between the groups were observed ($p < 0.05$) periods from 44 to 74 and from 74 to 104 days of age, apparently the calf feeding technology had no effect on growth in first month of calves life. The calves of AG group showed significantly higher growth rates (Table 3).

Table 3. Liveweight changes of one calf during trial (n=13)

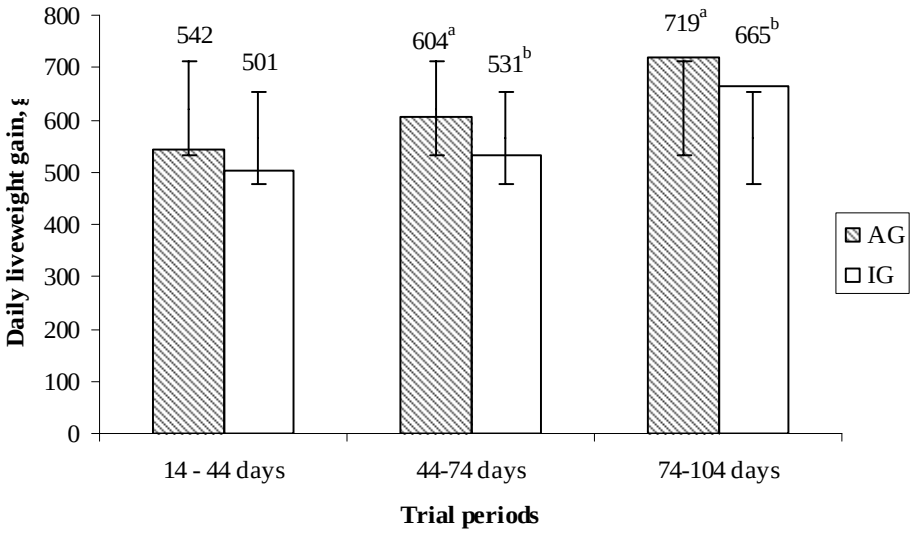
Liveweight control periods	Groups	
	IG	AG
Liveweight at 14 days of age	42.5 ±1.36	43.1 ± 1.72
Liveweight at 44 days of age	57.9 ± 1.55	59.7 ± 1.76
Liveweight gain in first month	15.3 ± 0.65	16.6 ± 0.27
Liveweight at 74 days of age	73.8 ± 1.57[a]	77.6 ± 1.98[b]
Liveweight gain in second month	15.9 ± 0.26[a]	17.9 ± 0.47[b]
Liveweight at 104 days of age	93.8 ± 1.55[a]	99.3 ± 2.28[b]
Liveweight gain in third month	20.0 ± 0.30[a]	21.7± 0.50[b]

[ab] – $p < 0.05$

The our trial results was similar to the other research data from the Grober Young Animal Development Centre in Woodstock, Ontario where compared calves in groups (fed via an automatic calf feeding machine) and individual pens (fed twice daily). All calves received a daily allowance of 6 liters of the same milk replacer. Results show that calves in groups exceeded average daily gains compared to individually housed calves starting week 5 and continuing past weaning. Achieving higher levels of milk intake when feeding only twice per day can often be challenging; manure becomes thin and is anecdotally depicted as diarrhea. The concept of smaller meals being offered more frequently could lead to improved digestion and may also aid in the prevention of severe scouring. There are perceived health concerns when calves have nose-to-tail contact. In group housing with automated feeding systems, labor is relieved from preparing, feeding and cleaning duties associated with milk delivery and so more time can be invested in observing calves and proactive identification of subclinical calves. Automatic calf feeder systems are also a tool for early detection of illness through intake monitoring. This can lead to minor illnesses being treated early, thus preventing more debilitating illnesses and reducing the overall cost of medications.

The feeding techologies of calves is always connected with the kind of the housing. Calf producers have often raised calves in individual pens or cages. This system of calf rearing has advantages of individual feeding, observation and reduced risk of cross-contamination. It is, however, still labor-intensive. Dairy

cattle are naturally group-living animals. Group-housed calves can facilitate early social interaction and learn to understand group behavior. Group housing of calves has many time and labor-saving advantages. It provides improved access to space, allowing for more vigorous activity, and with automation, it improves feed consistency and number of feedings. Group housing can facilitate earlier socialization. Moreover, there may be minimization of stress associated with changes in feed and environment post-weaning for calves. Aggression between calves is rare, and calves seem to habituate to repeated mixing. In the many research was evaluated management systems for rearing calves fed milk replacer**.**

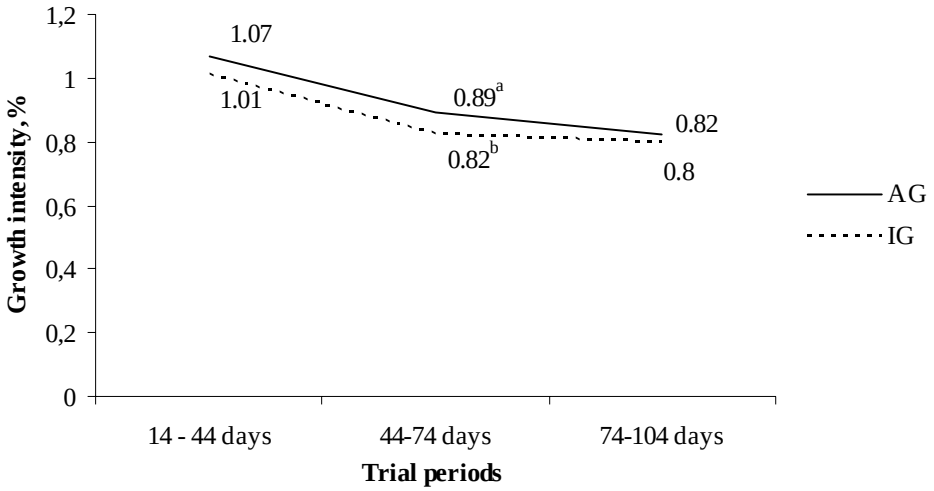


a,b – $p < 0.05$

Fig.1. The daily liveweight gain of calf in trial 3 months

The researchers (Kung, *et.al*, 1997) in two experiments, 54 dairy calves were allotted to one of two management systems. One-half of the calves was raised under a conventional system that consisted of housing in separate calf hutches and manually feeding milk replacer twice daily until weaning at 7 to 8 week of age. In this system, calves had ad libitum access to a starter diet. The remainder of the calves was housed in a single group pen and was fed via a computerized system that allowed controlled access to milk replacer and starter for 24 h d^{-1}. In both experiments, average daily gain and final body weight at weaning were similar between management systems. In Experiment 2, calves that were fed milk replacer via the automated system consumed more starter diet during the 2nd and 3rd week, but consumed less starter during week 6 and 7; however, total consumption of the starter diet prior to weaning was not different between treatments. Calves in the group pen had fewer days of medication than did those in hutches. The time needed to manage a calf in a hutch amounted to approximately 10 min per calf, but the time committed to management of a calf raised in the group pen was < 1 minute day. A 200 cow dairy herd with a 35% yearly cull rate and a mean calf mortality rate of 10% would regain costs of initial investment for the computer feeder by savings in labor within 2 to 3 yr.(Kung, *et.al*, 1997)

But in our study the growth rate intensity of calves showed that at the beginning of the trial for both groups were similar, respectively the IG 1.01 and AG 1.07%, but starting with 44 days growth rate differed significantly ($p < 0.05$). At the 104 days of age calf growth rate intensity was also a little higher in the AG group of calves, but not significant (Fig. 2).



a,b – $p < 0.05$

Fig. 2. Growth intensity of calf

But nevertheless to good growth results of calves the feed consumption in our trial was higher than could find in literature. The feed consumption at the end of trial were 2.98 kg DM for one kg liveweight gain in IG group and in AG group 2.72 kg . In the literature was said that the kg of DM for milk, concentrate and hay consumed per kilogram of weight gained was 2.3 kg for once daily feeding calves and 2.2 kg for twice daily feeding calves (Gleeson, *et.al.*, 2007). These intakes are similar to those reported by Galton and Brakel (Galton & Brakel, 1976) with conversion rates of 2.27 and 2.04 kg for calves fed milk replacer once and twice daily, respectively.

CONCLUSIONS

1. Automatic group (AG) female calves which received milk mixture of milk machine during small portions had live weight at the end of the study significantly higher ($p < 0.05$) than the individual group (IG) female calves which fed from the buckets 2 times a day, respectively, 99.3 ± 2.28 and 93.8 ± 1.55 kg.

2. The live weight gain differ significantly between groups ($p < 0.05$), and were higher for AG calves, in the trial period of the 44 – 74 and 74 -104 days, but from 14 – 44 days was no difference.

3. The daily live weight gain also differ significantly between groups ($p < 0.05$) in the trial periods of the 44 till 74 and 74 till 104 days and were from 501 till 719 g d^{-1}

4. The female calves had the highest growth rate intensity during the period of 14 – 44 days in both groups. The significant differences in growth rate intensity of calves ($p < 0.05$) between the IG and AG group was only during the period from 44 – 74 days.

5. The feed consumption at the end of trial were 2.98 kg DM for one kg liveweight gain in IG group and 2.72 kg in AG group.

6. The study results showed that the higher growth rates intensity showed AG group female calves at equal feed consumption after 44 days age, but till this age the milk feeding technology did not significantly influence female calves growth.

ACKNOWLEGEMENT

This publication was supported by ERAF contract Nr.2010/0198/2DP/2.1.1.2.0/10/APIA/VIAA/020

REFERENCES

Ahmed A., Constable P., Misk N. (2005) Effect of orally administered omeprazole on abomasal luminal ph in dairy calves fed milk replacer. *Journal Veterinary Medicine,* 52, pp. 238 – 243.

Birģele E. (2011) Milk replacer feeding and the functional condition of calf and goat abomasums. Animal hygiene and sustainable livestock production: proceedings of the XVth International congress of the International Society for Animal Hygiene, Vienna, Austria, 3-7 July 2011 / *International Society for Animal Hygiene. Institute for Veterinary Public Health.* Vienna, Vol.3, pp.1197 – 1199.

Chua B., Coenen J., Van Delen J., Weary D.M. (2001) Effects of pair versus individual housing on the behaviour and performance of dairy calves. *J. Dairy Sci.,* 85:360 – 364.

Constable P., Ahmed A., Misk N. (2005) Effect of suckling cow's milk or milk replacer on abomasal luminal ph in dairy calves. *Journal Veterinary Medicine,* 19, pp. 97 – 102.

Daniels S., Hills S., Knowlton K., James M., McGilliard M.L., Akers R. (2008) Effect of milk replacer composition on selected blood metabolites and hormones in preweaned Holstein heifers. *J. Dairy sci*., 91, pp. 2628 – 2640.

Davis C.L., Drackley J.K. (1998) *The development, nutrition, and management of the young calf.* Ames, Iowa: Iowa State University Press.

Earley B., Murray M., Farrell J.A., Nolan M. 2004) Rearing calves outdoors with and without calf jackets compared to indoor housing on calf health and live-weight performance. *Irish J. Agri. Food. Res.*, 43:59-67.

Eihvalde I., Kairiša D. (2012) Dažādas imunoglobulīnu koncentrācijas jaunpiena izēdināšanas ietekme uz vaislas teļu augšanu. *Ražas svētki "Vecauce - 2012" : Studijas – zinātne – prakse : zinātniskā semināra rakstu krājums* / Latvijas Lauksaimniecības universitāte, Lauksaimniecības fakultāte. SIA LLU mācību un pētījumu saimniecība "Vecauce" , Jelgava, LLU, lpp. 18 – 22.

Fallon R.J., Harte F.J. (1974) Effect of 'cold' feeding of milk replacer on calf performance. *Anim Prod.,* 15:8 – 9.

Fallon R.J. (1999) General Principles of Management of Calves. *In Proceedings of Teagasc Symposium. Kilkenny,* Ireland: Kildalton, Co; pp. 1 – 46.

Galton D.M., Brakel W.J. (1976) Influence of feeding milk replacer once versus twice daily on growth, organ measurements, and mineral content of tissues. *J. Dairy Sci*., 59:944 – 948

Gleeson D., O'Brien B., O'Donovan K. (2008) The labour input associated with calf care on Irish dairy farms. *Livest Sci*., 116:82 – 89.

Gleeson D., O'Brien B., Fallon R.J. (2007) Feeding of cold whole milk once daily to calves in a group and its effect on calf performance, health and labour input. *J. Appl. Res. Vet. Med.*, 3:97–104.

Gleeson D., O'Brien B. (2012) Effect of milk feed source, frequency of feeding and age at turnout on calf performance, live-weight at mating and 1stlactation milk production. *Irish Veterinary Journal* , 65:18 doi:10.1186/2046-0481-65-18

Hepola H., Hanninen L., Raussi S., Pursiainen P., Arnikoivu A., Saloniemi H. (2008) Effect of providing water from a bucket or a nipel on the performance and behaviour of calves fed ad libitum volumes of acidified milk replacer. *J. Dairy Sci*., 91, pp. 1486 – 1496.

Hessle A., Nadeau E., Svenson C. (2004) Feeding dairy calves and replacement heifers in South – western Sweden. *Acta Agriculturae Scandinavica.* 54: 2 pp. 94 – 102.

Kennedy E., Coughlan F., Fitzgerald S., Buckley F. (2011) The importance of target weight when rearing heifers. *Proceedings of Teagasc Irish Dairying Planning for 2015*, Moorepark Open day 2011, pp. 65-66.

Khan M., Lee W., Kim H., Ki k., Hur T., Suh G. (2007) Structural growth, rumen development and metabolic, and immune responses of Holstein male calves fed milk through step – down and conventional methods. *J. Dairy Sci*., 90, pp. 3376 – 3387.

Kung L.J.R., Demarco S., Siebenson L.N., Joyner E., Haenlein G.F.W., Morris R.M. (1997) An evaluation of two management systems for rearing calves fed milk replacer. *J. Dairy Sci.* 80:2529-2533

Quigley J., Wolfe T., Elsasser T. (2006) Effects of aitional milk replacer feeding on calf health, growth and selected blood metabolites in calves. *J. Dairy sci*., 89, pp. 207 – 216.

Randall E.M., Swannack K.P. (1975) Once a day feeding for calves. *Exp. Husb.*, 28:44-52.

Strzetelski J., Niwinska B., Kowalczyk J., Jurkiewicz A. (2001) Effect of milk replacer feeding frequency and level on concentrate intake and rearing performance of calves. *Journal of animal and feed science* (Poland). 10 (3) pp. 413 – 420

Tochette K., O'Brien M., Coalson J. (2003) Liquid egg.as an alternative protein source milk replacers. *J. Dairy Sci*., 86 :8 pp. 2622 – 2628.

Williams P.E.V., Fallon R.J., Brockway J.M., Innes G.M., Brewer A.C. (1986) The effect of frequency of feeding milk replacer to preruminant calves on respiratory quotient and the efficiency of food utilization. *Anim. Prod.*, 43:367-375.

Jemeļjanovs A. (2001) *Piena lopkopība*. SIA Sigulda: "Jumis", pp. 37 – 69.

Jasper J., Weary D. M.(2002) Effects of Ad Libitum Milk Intake on Dairy Calves. *J. Dairy Sci*., 85:3054–3058