Calf Management

Proceedings from the conference

Calf Management
Steinkjer, Norway
20-22 June 2007

Arranged by:

Sponsored by:

Nord-Trøndelag University College

Steinkjer 2007

Proceedings from the conference

Calf Management
Steinkjer, Norway
20-22 June 2007

Hanne Solheim Hansen
(ed.)

Nord-Trøndelag University College
The Faculty of Social Sciences and Natural Resources
ISBN 978-82-7456-520-3
Steinkjer 2007

Preface

It is with great pride that I write the preface for the conference Calf Management 2007. The conference is one of the major events during the International Calf Festival in Steinkjer 2007.

Cattle are calves for only 6 months, and during this period they do not draw much attention to themselves. Therefore, thorough daily routines easily can be overlooked. Making it is easy to forget the animal welfare and economic consequences of sub-optimal calf management.

In Steinkjer, agriculture is the backbone of the economy, and the farmers in the region are very positive and optimistic and care greatly for their animals. Several smaller studies have been performed in the region about the well-being and the economics of calf management. The results of these studies have made all the farmers in the region well aware of how important calf management is in dairy and beef production. This attitude is a great inspiration for more research and for the education of the Bachelor students in animal husbandry at Nord-Trøndelag University College.

The scientific committee, Professor Olav Østerås, Senior researcher Arne Ola Refsdal, Chief advisor Kolbjørn Nybø and Associate Professor Hanne Solheim Hansen, have designed the program for the conference. The proceedings have come together based on manuscripts from most of the speakers at the conference. This is one of the more extensive collections of updated literature about calf raising, including immunity, health, feeding, housing, beef calves and calf-welfare. Thanks to Hege Hjelde for making all the word formatting come together in a nice manner.

Thank you all for your efforts in making the content of the proceedings and the conference educational and memorable.

Associate professor
Hanne Solheim Hansen
Chair of conference

Contents

1 Immunity

1.1 Colostrum management for dairy calves

Sandra Godden DVM, DVSc
Department of Veterinary Population Medicine, University of Minnesota, Minnesota, U.S.A.

1.1.1 Abstract

Colostrum is the single most important management factor determining calf health and survival. Calves experiencing successful passive transfer of colostral immunoglobulins have improved preweaning health and survival, improved growth rate and feed efficiency, reduced age at onset of puberty, reduced age at first calving, and improved first and second lactation milk production. Unfortunately, many producers continue to suffer significant losses related to poor colostrum management. To achieve successful passive transfer the calf must consume a sufficient mass of Ig in colostrum, and then be able to successfully absorb these Ig molecules into its circulation. Factors affecting the mass of Ig consumed by the calf include 1) ***Quality*** of colostrum (i.e. Ig concentration in the colostrum) and 2) ***Quantity*** (volume) of colostrum fed. Major factors affecting uptake or absorption of these Ig molecules into circulation include 3) ***Quickness*** of providing the first colostrum feeding after birth and 4) ***Cleanliness*** of colostrum (i.e. bacterial contamination). Finally, producers must ***monitor*** the colostrum program to know if it is succeeding. The objective of this paper is to discuss these key components of, and provide recommendations for, developing successful colostrum management programs on commercial dairy farms.

1.1.2 Sammendrag

Råmelk er den enkeltfaktoren som har størst betydning for kalvens helse og overlevelse. Kalver som får god passiv immunitet via immunglobuliner fra råmelk har bedre helse og overlevelse, bedre tilvekst og fôrutnyttelse, redusert alder ved puberitet, lavere alder ved første kalving og høyere ytelse i første og andre laktasjon. Dessverre er det fortsatt mange gårdbrukere som har stort tap av kalver på grunn av dårlige rutiner med råmelkstilførsel. For å oppnå god passiv immunitet, må kalvene få tilstrekkelig mengde Ig fra råmelk, og i tillegg være i stand til å absorbere denne Ig. Faktorer som påvirker mengden av Ig som blir gitt til kalven er 1) ***Kvaliteten*** av råmelken (konsentrasjonen av Ig i råmelk) og 2) ***Kvantiteten*** (mengden) av råmelk som blir gitt. De viktigste faktorer som påvirker absorpsjonen av disse Ig molekylene er 3) ***Quickness***, hvor raskt etter fødsel første råmelk blir tildelt og 4) ***Renhet*** av råmelken (innhold av bakterier). Dernest er det viktig at gårdbrukere sjekker hvordan rutinene for råmelkstildelingen fungerer. Formålet med denne presentasjonen er å diskutere disse nøkkelfaktorene og å foreslå anbefalinger for rutiner for råmelkstildeling som fører til god immunitet hos kalver i melkebesetninger.

1.1.3 Why is Colostrum Important?

Because of the structure of the bovine placenta, calves are born without circulating protective antibodies. For protection against infectious pathogens during the first weeks of life, the calf

is almost entirely dependent upon the absorption of maternal immunoglobulin (Ig) from colostrum. In addition to Ig, colostrum is also an important source of non-specific immune factors and nutrients. Absorption of Ig from the intestine and into the calf's circulation is termed 'passive immunity'. Calves are defined as having failure of passive transfer (FPT) if the calf serum IgG concentration is less than 10 mg/ml when sampled between 24 – 48 hours of age. Achieving early and adequate intake of high quality colostrum is the single most important management factor in determining calf health and survival (Davis and Drackley, 1998). Additional benefits include improved growth rate and feed efficiency, reduced age at onset of puberty, reduced age at first calving, and improved first and second lactation milk production (DeNise et al., 1989; Wells, 1996; Fowler, 1999; Faber et al., 2005).

Unfortunately, many producers continue to suffer significant losses related to poor colostrum management. In the United States, preweaning mortality rates in dairy heifers are estimated to range between 8 – 11% (NAHMS, 1993, 1996, 2002). Poor colostrum management is one of the key factors contributing to these excessive losses: In one study 41% of 2177 calves sampled between 24 to 48 hours of age had FPT (serum IgG < 10 mg/ml; NAHMS, 1996). It was estimated that approximately 31% of preweaning death loss in dairy calves could be prevented if producers could improve their colostrum management practices (Wells, 1996). These studies point to the need for producers to adopt practices to improve colostrum management on their dairies. The objective of this paper is to discuss the key components of, and provide recommendations for, developing successful colostrum management programs on commercial dairy farms.

1.1.4 Components of a Successful Colostrum Management Program

To achieve successful passive transfer the calf must consume a sufficient mass of Ig in colostrum, and then be able to successfully absorb these Ig molecules into its circulation. Factors affecting the mass of Ig consumed by the calf include 1) ***Quality*** of colostrum (i.e. Ig concentration in the colostrum) and 2) ***Quantity*** (volume) of colostrum fed. Major factors affecting uptake or absorption of these Ig molecules into circulation include 3) ***Quickness*** of providing the first colostrum feeding after birth and 4) ***Cleanliness*** of colostrum (i.e. bacterial contamination). Finally, producers must ***monitor*** the colostrum program to know if it is succeeding. Each of these factors will be discussed separately:

1.Factors Affecting Colostrum Quality

High quality colostrum has an IgG concentration > 50 g/L. Unfortunately, the quality of colostrum from different cows and farms can be highly variable. In one recent study, colostrum IgG averaged 76 mg/ml, but ranged from 9 to 186 g/L for individual cows (Swan et al., 2007). Some factors affecting colostrum quality, such as breed, age of the dam, or season, may be out of the producer's control. However, there are several important factors affecting colostrum quality, over which producers do have control:

1.a Dry period nutrition. Producers should feed dry cow rations that achieve recommended levels of energy, protein, vitamins and minerals. Producers should also encourage maximum dry matter intake by providing unrestricted access to fresh palatable feed and water, and avoiding stressors such as heat-stress, overcrowding, or poor cow comfort. These steps will benefit both colostrum quality and cow health and production.

1.b Vaccinating pregnant cows and heifers. Vaccinating pregnant cows and heifers during the final 30 to 60 day period preceding calving increases the concentration of protective

colostral antibodies against such common enteric pathogens of calves as *Escherichia coli*, Rotavirus, Coronavirus, and Clostridial infections.

1.c Dry period length. Secretion of antibodies from the dam's circulation into the mammary gland begins approximately 5 weeks prior to calving. Cows with excessively long (> 90 days) or excessively short dry periods (< 21 days) produce lower quality colostrum. Furthermore, cows with excessively short dry periods produce lower volumes of colostrum (Rastani et al., 2005).

1.d Rapid harvest of first milking colostrum. The concentration of Ig in colostrum is highest immediately after calving, but begins to decrease over time if milking is delayed. In one study, delaying harvest of colostrum for 6 hrs, 10 hrs, or 14 hrs after calving resulted in a 17%, 27% and 33% decrease in colostral IgG concentration, respectively (Moore et al., 2005). To collect the highest quality colostrum, producers should strive to milk the cow within 1-2 hrs after calving if possible (goal: 6 hrs maximum delay).

1.e Test colostrum quality. It is difficult to predict which colostrum is high vs low quality. For example, even though first calf heifers are known to produce colostrum of slightly lower quality than older cows, heifer colostrum can still be quite excellent (Tyler et al., 1999). As such, producers should not automatically discard heifer colostrum without first testing it. Quick and inexpensive cow-side tests such as the colostrometer, an instrument that estimates colostrum quality by measuring specific gravity, can be useful to differentiate high from low quality colostrum.

2. Quantity of Colostrum Fed at first feeding.

In order to achieve successful passive transfer in an average 43 kg (90 lb) Holstein calf, experts calculate that producers should feed at least a minimum mass of 100 g of IgG in the colostrum (Davis and Drackley, 1998). So what volume of colostrum should producers feed in order to achieve this minimum dose? Obviously the answer to this question depends on the quality (IgG concentration) of the colostrum being fed. For example, if colostrum was known to contain 50 g/L IgG, then the producer would only need to feed 2 L to achieve the goal of ingesting 100 g IgG. However, if the colostrum only contained 25 g/L of IgG, then the producer would need to feed 4 L to achieve the same ingested mass of IgG. Because we frequently do not know the concentration of IgG in the colostrum being fed, it is currently recommended that calves be fed 10-12% of their body weight of colostrum at first feeding. For a 43 kg (90 lb) Holstein calf, the producer would feed 3.8 L (4 quarts) of colostrum at first feeding. Studies have demonstrated that Holstein calves fed 4 quarts (vs 2 quarts) of colostrum at first feeding had significantly higher serum IgG concentrations at 24 hrs of age (Morin et al., 1997). Another study reported that Brown Swiss calves fed 4 quarts (vs 2 quarts) of colostrum at first feeding had significantly higher rates of average daily gain and higher levels of milk production in both the first and second lactation (Faber et al., 2005).

3. Quickness of Providing the First Colostrum Feeding.

The term 'open gut' refers to the ability of newly born calves to absorb large Ig molecules, intact, across the intestinal epithelium and into the circulation. While the gut is 'open', the efficiency of Ig absorption will be greatest (20-40%) during the first one or two hours after birth. Unfortunately, the efficiency of Ig absorption begins to decrease very soon after birth in a process referred to as 'gut closure'. By 9 hours after birth, the efficiency of Ig absorption is reduced by 50%. By 24 hours after birth, the gut is completely 'closed' (Weaver et al., 2000). Feeding colostrum after the gut has closed will still offer the benefit local immunity in the gut lumen, but Ig absorption into the circulation will no longer occur. In order to achieve maximum efficiency of Ig absorption, producers should aim to provided the first feeding of colostrum within 1-2 hours of birth if possible (goal: 6 hrs maximum delay). Allowing calves to suckle the cow results in higher rates of failure of passive transfer because of delays in voluntary suckling and lack of control over volume consumed (Edwards and Broom, 1979). To avoid these problems, it is recommended that producers hand-milk the dam and then hand-feed colostrum to the calf using a nipple bottle or esophageal tube feeder.

4. Colostrum Cleanliness

Though colostrum is an important source of nutrients, non-specific immune factors and immunoglobulins, it can also represent one of the earliest potential exposures of dairy calves to infectious agents including *Mycoplasma* spp., *Mycobacterium avium* subsp. *paratuberculosis* (*Map*), fecal coliforms and *Salmonella* spp. (Steele, 1997; Streeter et al., 1995; Walz et al., 1997). This is a concern because pathogenic bacteria in colostrum could cause diseases such as scours or septicemia. This is also a concern because bacteria in colostrum may interfere with passive absorption of colostral antibodies out of the gut and into the circulation (James et al., 1981: Poulson et al., 2002). Experts recommend that fresh colostrum fed to calves contain fewer than 100,000 cfu/ml total bacteria count (TPC) and fewer than 10,000 cfu/ml total coliform count (McGuirk and Collins, 2004). Unfortunately, observational studies have indicated that average levels of bacterial contamination fed on commercial dairies are significantly higher than this cutpoint. In one study of Wisconsin dairy herds, 82% of samples tested exceeded the upper limit of 100,000 cfu/ml TPC (Poulson et al., 2002). The following section presents some practical methods to assist producers in feeding clean colostrum to calves:

4.a Prevent Bacterial Contamination During Colostrum Harvest, Storage or Feeding. In a study of colostrum on one dairy, total bacteria counts (TPC) were very low or nil in colostrum stripped directly from the gland (geometric $mean_{udder}$ TPC = 27.5 cfu/ml). However, significant bacterial contamination occurred during the process of milking the colostrum into the bucket (geometric $mean_{bucket}$ TPC = 97,724 cfu/ml) (Stewart et al., 2005). These results emphasize the importance of minimizing contamination by properly prepping udders prior to harvesting colostrum, milking into a clean, sanitized bucket, and transferring colostrum into clean, sanitized storage or feeding equipment.

4.b Minimize Bacterial Growth in Stored Colostrum. It is well understood that bacteria counts in colostrum or milk can multiply rapidly if stored at warm ambient temperatures. Unless colostrum is to be fed right away, it should be frozen or refrigerated within 1 hour after collection. It is generally thought that colostrum may be frozen for up to 1 year, provided repeated multiple freeze-thaw cycles do not occur. When thawing frozen colostrum, producers should avoid overheating colostrum (avoid temperatures > 60 °C) or else inactivation of colostral Ig can occur. Options for producers who wish to store fresh (not frozen) colostrum include refrigeration and/or the use of preservatives such as potassium

sorbate (0.5% final solution in colostrum) (Stewart et al., 2005; Godden et al., 2007). The shelf-life of stored fresh colostrum, before average total bacteria counts exceed the upper limit of 100,000 cfu/ml, is estimated to be:

- Ambient temperature (22 °C): < 24 hrs
- Ambient temperature with potassium sorbate preservative: 1-2 days
- Refrigerated (4 °C): 2 days
- Refrigerated with potassium sorbate preservative: 6-7 days

Information on potassium sorbate suppliers, mixing and use can be found at: http://www.atticacows.com/orgMain.asp?orgid=19&storyTypeID=&sid=&.

4.c Use of Commercial Colostrum Replacer Products. Powdered commercial colostrum replacement (CR) products contain bovine Ig that is typically either lacteal-derived or plasma-derived, and must also contain a source of dietary protein, energy, vitamins and minerals at levels similar to maternal colostrum. The CR should contain a minimum of 100 grams of IgG per dose (Quigley et al., 2001). Results of early CR research have shown mixed results, with some studies failing to achieve successful passive transfer in calves fed CR (Quigley et al., 2001; Swan et al., 2007). However, other studies have reported better rates of successful passive transfer (serum IgG > 10.0 mg/ml), particularly when calves were fed higher doses (IgG mass) in a CR product. In one such study, the average 24 hr serum IgG level for calves fed either 1 dose (100 g IgG) or 2 doses (200 g IgG) of a lacteal-derived commercially available colostrum-derived product were 11.6 ± 2.9 mg/ml and 16.9 (± 6.2) mg/ml, respectively (Land O' Lakes Colostrum Replacement. Land O' Lakes Inc. St. Paul, MN; Foster et al., 2006). Feeding high doses of CR products may offer producers a convenient way to provide adequate passive immunity to calves while reducing the risk of pathogen exposure through colostrum, and is certainly recommended in situations where a sufficient volume of clean, high quality colostrum is not available from the cow or when stored colostrum is not available. These products have the added benefit of being convenient to quickly mix and feed. Large scale, long-term studies are still needed to describe the health and economic-benefit of adopting the practice of feeding CR as a routine management tool.

4.d Feeding Pasteurized Colostrum. Early research pasteurizing colostrum using the same conventional methods and temperatures as are typically used to pasteurize milk will yield unacceptable results including thickening of colostrum and denaturation of approximately 1/3rd of colostral IgG (Green et al., 2003; Godden et al., 2003). However, recent research has determined that using a lower-temperature, longer-time approach (140 °F (60 °C) for 60 minutes) to batch pasteurize colostrum should be sufficient to maintain IgG levels and fluid characteristics while eliminating or significantly reducing important pathogens including *E. coli*, *Salmonella enteritidis*, *Mycoplasma bovis* and *Map* (McMartin et al, 2006; Godden et al., 2006). In one recent study, newborn calves fed 3.8 L of pasteurized colostrum had significantly higher serum IgG levels at 24 hrs of age (22.3 mg/ml) than calves fed 3.8 L of raw colostrum (18.1 mg/ml). This improvement is thought to be due to reduced bacterial interference with IgG absorption across the gut, resulting in higher efficiency of IgG absorption in calves fed pasteurized colostrum (35%) vs calves fed raw colostrum (27%) (Johnson et al., 2007). If put in a clean covered container, the shelf life of pasteurized refrigerated colostrum is at least 8 to 10 days (Bey et. al., 2007). The potential health and economic benefits of feeding pasteurized colostrum have not yet been described.

5. Monitoring the Colostrum Management Program

Producers should first monitor health records in preweaned calves. Goals for preweaning treatment and mortality rates are < 25% and < 5%, respectively (McGuirk and Collins, 2004). If health problems exist, then producers will need to investigate if this is due to poor

colostrum management versus other possible causes such as poor sanitation, poor housing, poor nutrition, or other stressors. To monitor if successful passive transfer is being achieved in calves, producers could measure serum IgG concentrations using RID or TIA assays in a laboratory. However, a more rapid and inexpensive indirect estimate of serum IgG can be achieved by periodically measuring serum total protein (STP) levels. This is done by collecting a blood sample from 12 or more clinically normal calves between 1 to 7 days of age, letting the blood clot, and then testing the serum using a hand-held refractometer instrument. If the program is succeeding then ≥ 90% of calves tested should have a STP value ≥ 5.0 gm/dl. As a final step, producers can monitor colostrum cleanliness by periodically submitting frozen colostrum samples to a microbiology lab for culture. A goal is for a majority of samples submitted to have at total bacteria count of < 100,000 cfu/ml.

1.1.5 Conclusion

Colostrum management is the single most important management factor in determining calf health and survival. A successful colostrum management program will require feeding a sufficient volume of high quality, clean colostrum to the calf within a few hours after birth. Producers may monitor the success of the colostrum management program by evaluating calf treatment and mortality records, periodically measuring serum total protein or serum IgG measures to assess passive transfer of Ig, and periodically culturing colostrum to assess levels of bacterial contamination.

1.1.6 Literature

Bey, R., S. Godden, H. Lillegaard, S. Stewart, P. Rapnicki, R. Farnsworth. 2007. Improving cleanliness and shelf-life of refrigerated colostrum using heat-treatment and chemical preservatives. Proc. Annu. Meet. Minnesota Dairy Health Management Conference. St. Paul, MN. May 15-17, 2007.

Davis, C.L. and J.K. Drackley. 1998. Pages 179-206 in: The Development, Nutrition, and Management of the Young Calf. 1st Ed. © 1998. Iowa State University Press. Ames, IA.

DeNise, S.K., J.D. Robison, G.H. Stott, D.V. Armstrong. 1989. Effects of passive immunity on subsequent production in dairy heifers. J. Dairy Sci. 72:552-554.

Faber, S.N., N.E. Faber, T.C. McCauley, and R.L. Axe. 2005. Effects of colostrum ingestion on lactational performance. The Professional Animal Scientist. 21:420-425.

Foster, D.M., G.W. Smith, T.R. Sanner, and G.V. Busso. 2006. Serum IgG and total protein concentrations in dairy calves fed two colostrum replacement products. J. Am. Vet. Med. Assoc. 229:1282-1285.

Fowler, M. 2006. *In Proc*. Land-O-Lakes Calf College. Mar. 1, 2005. St. Paul, MN.

Godden, S.M., S. Smith, J.M. Feirtag, L.R. Green, S.J. Wells, and J.P. Fetrow. 2003. Effect of on-farm commercial batch pasteurization of colostrum on colostrum and serum immunoglobulin concentrations in commercial dairy calves. J. Dairy Sci. 86:1503-1512.

Godden, S., S. McMartin, J. Feirtag, J. Stabel, R. Bey, S. Goyal, L. Metzger, J. Fetrow, S. Wells, and H. Chester-Jones. 2006. Heat-treatment of bovine colostrum II: Effects of heating
duration on pathogen viability and immunoglobulin G. J. Dairy Sci. 89:3476-3483.

Green, L. 2003. Pasteurization of Non-saleable Milk and Colostrum in Commercial On-Farm Pasteurizers. MS Thesis. January, 2003.

James, R. E., C. E. Polan, and K. A. Cummins. 1981. Influence of administered indigenous microorganisms on uptake of [iodine-125] gamma-globulin in vivo by intestinal segments of neonatal calves. J Dairy Sci. 64(1):52-61.

Johnson, J., S. Godden, T. Molitor, T. Ames, D. Hagman. 2007. The effect of feeding heat-treated colostrum on passive transfer of cellular and humoral immune parameters in

neonatal dairy calves. J. Dairy Sci. *Submitted*.
Jones, C.M., James, R.E., Quigley, J.D. III, and M.L. McGilliard. 2004. Influence of pooled colostrum or colostrum replacement on IgG and evaluation of animal plasma in milk replacer. J. Dairy Sci. 87:1806-1814.
McGuirk, S. M. and M. Collins. 2004. Managing the production, storage and delivery of colostrum. Vet Clin North Am Food Anim Pract. 20(3):593-603.
McMartin, S., S. Godden, L. Metzger, J. Feirtag, R. Bey, J. Stabel, S. Goyal, J. Fetrow, S. Wells, and H. Chester-Jones. 2006. Heat-treatment of bovine colostrum I: Effects of temperature on viscosity and immunoglobulin G. J. Dairy Sci. 89:2110-2118.
Moore, M., J.W. Tyler, M. Chigerwe, M.E. Dawes, J.R. Middleton. 2005. Effect of delayed colostrum collection on colostral IgG concentration in dairy cows. J. Am. Vet. Med. Assoc. 226(8):1375-1377.
Morin, D.E., G.C. McCoy, and W.L. Hurley. 1997. Effects of Quality, Quantity, and Timing of Colostrum Feeding and Addition of a Dried Colostrum Supplement on Immunoglobulin G_1 Absorption in Holstein Bull Calves. 80:747-753.
National Animal Health Monitoring System. 1993. National Dairy Heifer Evaluation Project. Dairy Herd Management Practices Focusing on Preweaned Heifers. USDA-APHIS Veterinary Services. Ft. Collins, CO.
National Animal Health Monitoring System. 1996. Dairy 1996: National Dairy Health Evaluation Project. Dairy heifer morbidity, mortality, and health management focusing on preweaned heifers. USDA-APHIS Veterinary Services. Ft. Collins, CO.
National Animal Health Monitoring System. 2002. Dairy 2002. Part 1: Reference of Dairy Health and Management in the United States. USDA-APHIS Veterinary Services. Ft. Collins, CO.
Poulson 2002 Poulsen, K.P., F.A. Hartmann, and S.M. McGuirk. 2002. Bacteria in colostrum: impact on calf health. Abstr. 52 *in* Proc. 20th American College of Internal Veterinary Medicine. Dallas, TX. Pp. 773
Quigley, J.D. III, Strohbehn, R.E., Kost, C.J., and M.M. O'Brien. 2001. Formulation of colostrum supplements, colostrums replacers and acquisition of passive immunity in neonatal calves. J. Dairy Sci. 84:2059-2065.
Rastani, R.R., R.R. Grummer, S.J. Bertics, A. Gümen, W. Wiltbank, D. Mashek, and M.C. Schwab. 2005. Reducing dry period length to simplify feeding transition cows: Milk production, energy balance and metabolic profiles. J. Dairy Sci. 88:1004-1014.
Steele, M.L., W.B. McNab, C. Poppe, M.W. Griffiths, S. Chen, S. A. Degrandis, L.C. Fruhner, C.A. Larkin, J.A. Lynch, and J.A. Odumeru. 1997. Survey of Ontario bulk tank raw milk for food-borne pathogens. J. Food Protection. 60(11):1341-1346.
Stewart, S., S. Godden, R. Bey, P. Rapnicki, J. Fetrow, R. Farnsworth, M. Scanlon, Y. Arnold, L. Clow, K. Mueller, and C. Ferrouillet. 2005. Preventing bacterial contamination and proliferation during the harvest, storage and feeding of fresh bovine colostrum. J. Dairy Sci. 88:2571-2578.
Streeter, R. N., G. F. Hoffsis, S. Bech-Nielsen, W. P. Shulaw, and D. M. Rings. 1995. Isolation of *Mycobacterium paratuberculosis* from colostrum and milk of subclinically infected cows. Am J Vet Res. 56(10):1322-1324.
Swan, H., S. Godden, R. Bey, S. Wells, J. Fetrow, and H. Chester-Jones. 2007. Passive Transfer of Immunoglobulin G and Preweaning Health in Holstein Calves fed a Commercial Colostrum Replacer. J. Dairy Sci. *Accepted 04/2007*.
Tyler, J.W., B.J. Steevens, D.E. Hostetler, et al. 1999. Colostral IgG concentrations in Holstein and Guernsey cows. Am. J. Vet. Res. 60:1136-1139.
Walz, P.H., T.P. Mullaney, J.A. Render, R.D. Walker, T. Mosser, and J.C. Baker. 1997. Otitis media in preweaned Holstein dairy calves in Michigan due to *Mycoplasma bovis*. J. Vet. Diagn. Invest. 9:250-254.
Weaver, D.M., J.W. Tyler, D.C. VanMetre, D.E. Hostetler, and G.M.

Barrington.2000.Passive transfer of colostral immunoglobulins in calves. J. Vet Intern Med. 14:569-577.
Wells , S.J., D.A. Dargatz, et al. 1996. Factors associated with mortality to 21 days of life in dairy heifers in the United States. Prev. Vet. Med. 29:9-19.

1.2 Colostrum quality in Norwegian dairy cows

Stine M. Gulliksen[1,2], Kai-Inge Lie[1], Liv Sølverød[2], Olav Østerås[1]
[1]Norwegian School of Veterinary Science, Oslo, Norway
[2]TINE Norwegian Dairies, Ås, Norway

1.2.1 Abstract

The objectives of the present study were to evaluate the colostrum quality in Norwegian dairy cows based on IgG content, and to identify associations between possible risk factors and colostral IgG content. During 2004 on to 2006 a longitudinal cross sectional survey on calf health in Norway was performed. The participating dairy herds were randomly selected among herds registered in The Norwegian Dairy Herd Recording System (NDHRS), having at least 15 cow years. The participating farmers sampled 10 ml of colostrum from the first milking after calving from 12 cows which calved during their defined project period of 365 days. The samples were taken from a healthy teat. Colostrum samples from 693 cows from 82 herds were sampled during September 2004 through April 2006. The IgG content in the colostrum sampled ranged from 3 to 235 g/l, with an overall mean of 51.4 g/l. Altogether 58.8 % of the samples contained less than the recommended 50 g IgG/l colostrum. Cows in their forth parity or more were found to have statistically significant higher levels of IgG per litre colostrum than cows of less than four parities. Colostrum from cows in their second parity had the lowest level of IgG. Cows calving during the winter months (December, January and February) produced colostrum with a significantly lower IgG content compared to cows calving during any other season of the year. Cows recorded having calving difficulties were found to have colostrum with lower IgG content than cows with normal calving. Altogether, 14.1% of the variation in colostrum quality could be explained by cluster effects within herd. As the majority of the Norwegian dairy cow population seems to produce colostrum of insufficient quality based on the international recommendations, the colostrum feeding regime of newborn calves should be adjusted according to this.

1.2.2 Sammendrag

Målene ved denne studien er å evaluere råmelkskvaliteten hos norske melkekyr basert på innhold av IgG, og å identifisere sammenhenger mellom variasjoner i råmelkskvalitet og eventuelle risikofaktorer. I 2004 ble prosjektet ”Kalve- og ungdyrhelse i Norge” startet. Besetninger med over 15 årskyr ble tilfeldig utplukket fra Kukontrollen. Alle besetninger deltok i prosjektet i ett år. Produsentene samlet inn 10 ml råmelk fra første mål etter kalving fra 12 kyr som kalvet i løpet av deres prosjektperiode. Råmelken ble tatt fra en frisk spene. Fra september 2004 t.o.m. april 2006 ble det samlet inn 693 råmelksprøver fra 82 besetninger. Innholdet av IgG i råmelka varierte fra 3 til 235 g/l, med et gjennomsnitt på 51,4 g/l. 58,8 % av prøvene inneholdt mindre enn de anbefalte 50g IgG/l råmelk. Kyr i fjerde laktasjon eller mer hadde signifikant høyere IgG-innhold i råmelka enn yngre kyr. Kyr i andre laktasjon produserte råmelk av dårligst kvalitet. Kyr som kalvet i vintermånedene (desember-februar) produserte råmelk med signifikant lavere IgG-innhold i forhold til kyr som kalvet ellers i året. Kyr med kalvingsvansker produserte råmelk av dårligere kvalitet enn kyr registrert med normale kalvinger. 14,1 % av variasjonen i råmelkskvalitet kunne forklares av klustereffekt innen besetning. Da majoriteten av norske melkekyr ser ut til å produsere råmelk av ikke tilfredsstillende kvalitet, bør fôringsregimet av råmelk til nyfødte kalver justeres i forhold til dette.

1.2.3 Introduction

Colostrum is the secretion from the mammary gland in the first 24 hours after calving (Jaster, 2005), and is an important source of nutritional-, growth-, and antimicrobial factors for the newborn calf (Blum & Hammon, 2000). As newborn calves are agammaglobulinemic at birth (Straub & Matthaeus, 1978), it is well documented that colostrum of good quality (i.e. containing high levels of immunoglobulins) fed as soon as possible after birth is a necessity to decrease disease susceptibility and neonatal mortality (Dardillat et al., 1978; Donovan et al., 1998; Tyler et al., 1999). Colostrum contains three types of immunoglobulins: IgG, IgM and IgA, where IgG accounts for over 75% of the total (Korhonen et al., 2000). To be classified as "high quality colostrum", international recommendations is set to a minimum of 50 g IgG/l based on studies showing significantly higher rates of failure of passive transfer (FPT) in calves receiving colostrum with IgG content below this limit (Besser et al.,1991; Liberg, 2000). Colostrum quality varies distinctly between individual cows (Maunsell et al.,1999; Pritchett et al.,1991; Liberg 2000), and between different breeds (Tyler et al., 1999; Norman et al., 1981; Muller et al.,1981; Quigley et al.,1994).

The objectives of the present study were to evaluate the colostrum quality in Norwegian Red Cattle based on IgG content, and to identify associations between possible risk factors and low levels of colostrum IgG content.

1.2.4 Materials and methods

In February 2004 a longitudinal cross sectional survey on calf health in Norway was initiated. Herds recorded in the Norwegian Dairy Herd Recording System (NDHRS) and having at least 15 cow years were included for further random sampling. To cover all parts of Norway, a total of 30 districts were selected. All together, a total of 198 dairy herds from all parts of Norway were selected (Figure 1). Of the 198 dairy farmers invited, 130 were willing to participate in the project, each participating for one whole year (365 days).

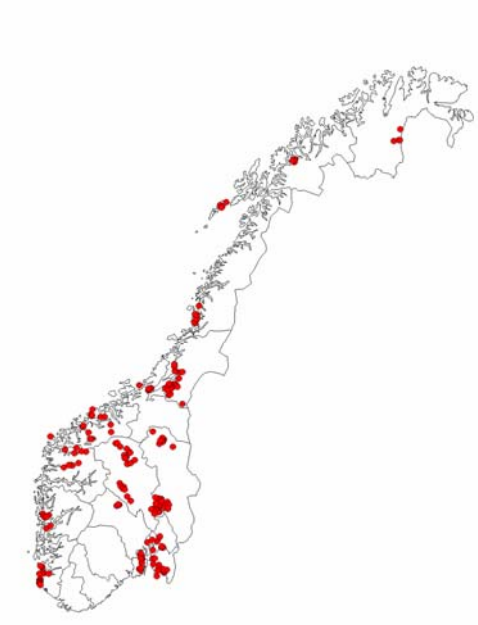


Fig. 1. Map of Norway indicating geographic location of selected dairy herds

All participating farmers were asked to submit 10 ml of colostrum from the first milking after calving from 12 cows which calved during their defined project period. The samples were taken from a healthy teat. From September 2004 through April 2006 a total of 693 colostrum samples from 82 herds were sampled. The material included 256 samples from first parity cows, 201 from second parity cows, 113 from third parity cows and 123 from cows in their forth parity or more. The samples were frozen immediately after collection, and then submitted to The Mastitis Laboratory in Molde. Analyses on IgG content was performed using single radial immunodiffusion.

Results from monthly milk analyses registered in NDHRS existed for 550 of 693 cows. Health data from NDHRS registered from 15 to 2 days before calving was included in the analyses.

SAS version 9.1 was used for the statistical analyses.

1.2.5 Results

The colostral IgG ranged from 3 to 235 g/l with an overall mean of 51.4 g/l. 58.8 % of the samples contained less than the recommended 50 g IgG/l colostrum. Cows in their forth parity or more were found to have significantly higher levels of IgG per litre colostrum than cows of less than four parities. Colostrum from cows in their second parity had the lowest content of IgG, although not significantly different from colostrum from first or third parity cows (Figure 2).

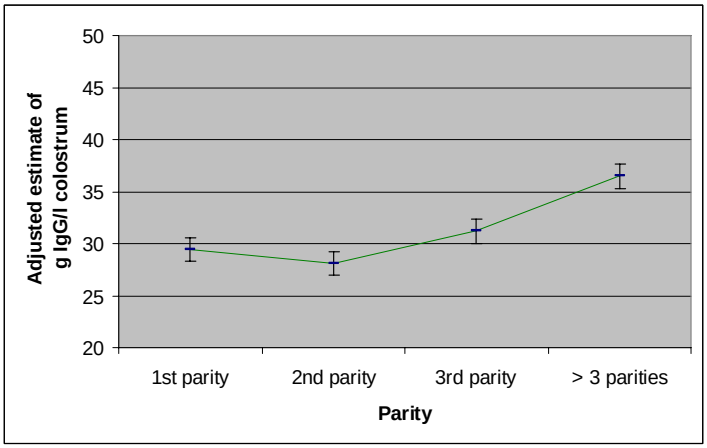


Fig.2. Colostral IgG content (g/l) in cows of different parities (bars: 95% Confidence Interval). Estimates are adjusted for all other factors.

Cows calving during the winter months (December, January and February) produced colostrum with a significantly lower IgG content compared to cows calving in any other season of the year. Cows calving during August, September or October produced colostrum of highest quality (Figure 3). Cows registered with dystocia produced colostrum with a significantly lower content of IgG than cows registered having gone through normal calving. SCC measured 7-66 days after calving was significantly higher in cows with colostrum of inferior quality than in cows producing high quality colostrum. We found a cluster effect within herd of 14.1%. No significant geographical variation in colostrum quality was found.

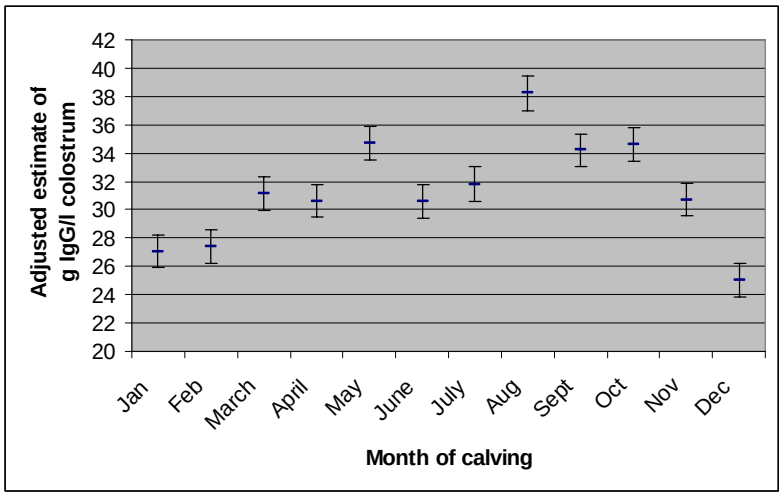


Fig.3. Colostral IgG content (g/l) in cows with various months of calving (bars: 95% Confidence Interval). Estimates are adjusted for all other factors.

1.2.6 Discussion

This study shows that the majority of Norwegian dairy cows produce colostrum with IgG content below 50 g/l. Like Shearer et al. (1992), we divided the colostrum in this study into two categories: satisfactory quality (>50 g IgG/l) and inferior quality (<50 g IgG/l). The average IgG content of 51.4 g/l in colostrum from Norwegian dairy cows is lower than the average concentration reported from Jersey cows (Quigley et al.,1994; Muller & Ellinger, 1980) and lower than some reports on Holstein (Maunsell et al.,1999). The results of this study support the findings of increasing IgG content with increasing parity (Tyler et al.,1999, Moore et al., 2005). Although the majority of the cows included in our study were of the breed NRF Norwegian Red, the present study is not sufficient to conclude on the general colostrum quality of this breed. This study gives us an indication of the huge differences between individual cows within the same breed.

According to our results, a cluster effect of 14.1% implies that management factors, i.e. feeding, environment, housing etc., which vary between farms are of great importance when it comes to variation in colostrum quality. Seasonal variation might be of more importance in Norway, than in other countries because of the marked variation in climate between the different seasons and in consequence variations during the year in occurrence of disease, feeding regime, indoor climate etc. which may influence udder health. We found that cows calving during autumn (August, September and October) produced colostrum of higher quality compared to cows calving during any other season of the year. According to Norwegian law, cows should spend at least 8 weeks on pasture each year; hence they are let out on pasture during summer months. Our results indicate that differences in colostrum quality should be taken into consideration when making plans concerning calving season on herd level.

A common phenomenon in the majority of the research done on colostrum quality, including the present one, is the wide range of variation in colostral IgG content from different cows within a restricted area. These individual variances make it difficult to draw conclusions concerning different risk factors and thereby providing sufficient advising when it comes to management and colostrum quality. However, as the majority of the Norwegian dairy cow population seems to produce colostrum of insufficient quality based on the international

recommendations, the colostrum feeding regime of newborn calves should be adjusted according to this.

1.2.7 Litterature

Besser,T.E., Gay,C.C., Pritchett,L., 1991. Comparison of three methods of feeding colostrum to dairy calves. J Am. Vet Med Assoc. 198: 419-422.

Blum,J.W., Hammon,H., 2000. Colostrum effects on the gastrointestinal tract, and on nutritional, endocrine and metabolic parameters in neonatal calves. Livest Prod Sci 66: 151-159.

Dardillat,J., Trillat,G., Larvor,P., 1978. Colostrum immunoglobulin concentration in cows: relationship with their calf mortality and with the colostrum quality of their female offspring. Ann. Rech. Vet. 9: 375-384.

Donovan,G.A., Dohoo,I.R., Montgomery,D.M., Bennett,F.L., 1998. Associations between passive immunity and morbidity and mortality in dairy heifers in Florida, USA. Prev Vet Med 34: 31-46.

Jaster,E.H., 2005. Evaluation of quality, quantity, and timing of colostrum feeding on Immunoglobulin G1 absorption in Jersey calves. J Dairy Sci 88:296-302.

Korhonen,H., Marnila,P., Gill,H.S., 2000. Milk immunoglobulins and complement factors. Br. J Nutr. 84 Suppl 1: S75-S80.

Liberg,P., 2000. Råmjølksutfodring - "En god start förlänger livet". Veterinärmøtet, Uppsala 133-139.

Maunsell,F.P., Morin,D.E., Constable,P.D., Hurley,W.L., McCoy,G.C., 1999. Use of mammary gland and colostral characteristics for prediction of colostral IgG1 concentration and intramammary infection in Holstein cows. J Am. Vet. Med. Assoc. 214: 1817-1823.

Moore,M., Tyler,J.W., Chigerwe,M., Dawes,M.E., Middleton,J.R., 2005. Effect of delayed colostrum collection on colostral IgG concentration in dairy cows. J Am. Vet. Med. Assoc. 226: 1375-1377.

Muller,L., Ellinger,D., 1981. Colostral immunoglobulin consentrations among breeds of dairy cattle. J Dairy Sci 64: 1727-1730.

Norman,L.M., Hohenboken,W.D., Kelley,K.W., 1981. Genetic differences in concentration of immunoglobulins G1 and M in serum and colostrum of cows and in serum of neonatal calves. J Anim Sci 53: 1465-1472.

Pritchett,L.C., Gay,C.C., Besser,T.E., Hancock,D.D., 1991. Management and production factors influencing immunoglobulin G1 concentration in colostrum from Holstein cows. J Dairy Sci 74: 2336-2341.

Quigley,J.D., III, Martin,K.R., Dowlen,H.H., Wallis,L.B., Lamar,K., 1994. Immunoglobulin concentration, specific gravity, and nitrogen fractions of colostrum from Jersey cattle. J Dairy Sci 77: 264-269.

Shearer,J., Mohammed,H.O., Brenneman,J.S., Tran,T.Q., 1992. Factors associated with concentrations of immunoglobulins in colostrum at the first milking post-calving. Prev Vet Med 14: 143-154.

Tyler,J.W., Steevens,B.J., Hostetler,D.E., Holle,J.M., Denbigh,J.L., Jr., 1999. Colostral immunoglobulin concentrations in Holstein and Guernsey cows. Am. J Vet. Res. 60: 1136-1139.

1.3 Natural and synthetic vitamin E for calves – importance for vitamin E status and immunity

Søren K. Jensen, Jakob Sehested, Mogens Vestergaard, Niels B. Kristensen
Department of Animal Health, Welfare and Nutrition, Faculty of Agricultural Sciences, Research Centre Foulum, University of Aarhus, DK-8830 Tjele, Denmark.

1.3.1 Abstract

Calves are born without detectable vitamin E (α-tocopherol) in the circulating blood. Thus, the vitamin E status of the newborn calf solely relies on the supply with colostrum. Vitamin E is an important antioxidant protecting cell membranes against oxidative damage and plays as a mediator of eicosanoid synthesis an important role in development and maturation of the cellular immune system. Vitamin E is most often added to the feed as synthetic all-*rac*-α-tocopherol acetate. This synthetic form of vitamin E consists of an equal amount of 8 stereoisomers of α-tocopherol, while tocopherols synthesized by plants and algae always posses the RRR configuration. Several investigations have shown a higher utilization of the natural form of vitamin E compared with the synthetic form, caused by a biodiscrimination within the animals. On the basis of experiments with rats, a conversion factor of 1.36 between all-*rac*-α-tocopherol and RRR-α-tocopherol has been established. However, several experiments with cattle have shown a much higher biodiscrimination against the synthetic stereoisomers of α-tocopherol than observed in rats, pigs, poultry and humans. Milk from high yielding cows is relatively low in vitamin E, whereby it is difficult to secure a sufficient vitamin E supply of the calf. The present paper describe different ways/methods to increase vitamin E status of calves both by maternal supply and by supply of synthetic or natural vitamin E directly into colostrum, cows milk, milk replacers or starter concentrates. Further the paper describes the relationship between vitamin E supply of the cows and stillbirth, as well as the effect of supplemental vitamin E on immune responses in calves.

1.3.2 Introduction

Vitamin E is a very important antioxidant for livestock and especially for young animals it serves as an important modulator in the maturation of the immune system. Traditionally, vitamin E is added to the diet as synthetic all-*rac*-α-tocopheryl-acetate. In the intestine this ester of α-tocopherol is incorporated into the mixed micelles of bile acids – phospholipids, free fatty acids and mono-, di- and triglycerides. This incorporation is a prerequisite for proper enzymatic action of the intestinal lipases secreted from the pancreas on the components in the micelles.

Function of vitamin E
The major function of α-tocopherol is as a major cellular antioxidant incorporated in the cell membranes protecting them against oxidative damage. In milk, meat and eggs vitamin E is necessary in order to avoid oxidative deterioration in the products.
Vitamin E influences both the celluar and the humoral immune function. The effect on cellular immune system is an increased production and a better function of the T-helper cells leading to an increased function of the cellular immune system. The effect on the humoral

immune system is an increased production of the antibody producing B-cells, apparently in collaboration with the T-helper cells in the initial phase of the immune response. Thus, vitamin E can improve the immune response by animal marginal deficient with vitamin E.
Other experiments have shown that vitamin E can modulate the production of prostaglandins both through influencing the release of arachidonic acids from phospholipids, as well as modulating the action of cyclooxygenase on arachidonic acid in the formation of prostaglandins. Prostaglandins and many of the other molecules formed upon the action of lipoxygenase and cyclooxygenase on arachidonic acid are very important for the production and function of the macrophages.
Finally the antioxidative effect of vitamin E is important in order to avoid unnecessary cell damage occurring as a side effect following the oxidative burst released by the macrophages.

Digestion of vitamin E
It is generally accepted that animals have adequate capacity for hydrolysing tocopheryl esters and other vitamin esters. However, in young animals as calves the hydrolysis of lipid esters as tocopheryl acetate these digestion processes can easily be disturbed due to an imbalance in the mixed micelles and below some of the important reasons for the impairment is listed. One major course is reduced secretion of pancreatic lipases, especially carboxyl ester hydrolase (CEH) which is responsible for cleavage of the ester linkage in tocopheryl esters. Hereby CEH may become the rate limiting determinant in hydrolysing tocopheryl esters, resulting in increased excretion of intact tocopheryl esters with feces and thereby significant decreased absorption of α-tocopherol.
A second factor is a decreased secretion of bile, whereby reduced amounts of bile acids, cholesterol and phospholipids are available for formation of the mixed micelles. Hereby the lipid droplets in the intestine become larger making it more difficult for the lipases to work on their surface – and more important the necessary lipase and CEH activators – conjugated bile acids – become lacking. This again results in an increased secretion of intact tocopheryl esters with feces.

Deconjugation of bile acids
Deconjugation of bile acids in the upper part of the small intestine by gram negative bacteria including *Clostridium perfringens* may in certain cases reduce lipid absorption because in solutions with Ca^{2+} deconjugated bile acids are likely to precipitate in the intestine and thereby be excreted as calcium salts with the feces instead of entering the enterohepatic circulation. In young animals where the synthesis of bile acids is limiting, factors leading to a decreased concentration of conjugated bile acids will impair lipid digestion.
It is clear that even a mild disturbance of the balance in the digestive tract will further decrease the hydrolysis and subsequent absorption at vitamin E. Thus diarrhoea and other disturbances will often increase the motility and impair the formation of mixed micelles, whereby the time available for hydrolysis and digestion can dramatically be reduced and cause malabsorption. Therefore, attempts that can reduce the need for hydrolysis of tocopheryl esters and improve the formation and stability of the mixed micelles will be very valuable for the young animals. In practise this means that the animals fed the alcohol form of α-tocopherol escape the need of CEH. Furthermore, providing the animals with emulsifiers like phospholipids will improve the formation and stability of the mixed micelles.

Bioavailability of synthetic and natural vitamin E
The alcohol form of α-tocopherol is absorbed directly from the mixed micelles without prior hydrolysis. Another part of the story deals with the chirality or the stereochemistry of the α-tocopherol molecule. Synthetic α-tocopherol consists of 8 stereo chemical different molecules designated RRR, RRS, RSS, RSR, SSS, SSR, SRR, SRS of which only the RRR form are

structurally identical to the tocopherols produced by nature in plants. Numerous animal experiments have shown that natural α-tocopherol is much more biological potent than the other isomers. The four 2S forms, which make up 50% of the synthetic α-tocopherol in the feed, (SSS, SSR, SRR, SRS) are excreted from the body already in the liver, due to very low affinity to the transport protein responsible for transporting α-tocopherol within the body. Thus the 2S forms show very poor vitamin E activity. The three synthetic 2R forms all show varying vitamin E activity, but all of them have a lower activity than natural RRR-α-tocopherol. For further reading and references see (Lauridsen et al. 2001; Knarreborg et al. 2004; Lauridsen and Jensen, 2005; Lauridsen and Jensen, 2006; Jensen and Lauridsen, 2007)

1.3.3 Materials and Methods

Cows and calves from Danish Holstein herds as well as the experimental farm at Foulum were used in the experiment. Blood samples were taken from the jugular vein in EDTA vacutainer tubes. Vitamin E was analysed in plasma by HPLC after saponification with KOH and extraction into heptane as described by Jensen et al. (2007).

1.3.4 Results and Discussion

Colostrum provides a good source for transferring vitamin E from cow to calf and as shown in Figure 1 the natural form is secreted more efficient into milk than the synthetic form especially in the first milking. These findings are in concordance with results of Meglia et al. (2006) who found a significant higher concentration of α-tocopherol in colostrum from cows fed 1000 IU RRR-α-tocopherol compared to 1000 IU all-*rac*-α-tocopheryl acetate.
The average α-tocopherol content in blood plasma from 55 calves from 1-69 days of age from eight different Danish organic herds is listed in Figure 2.

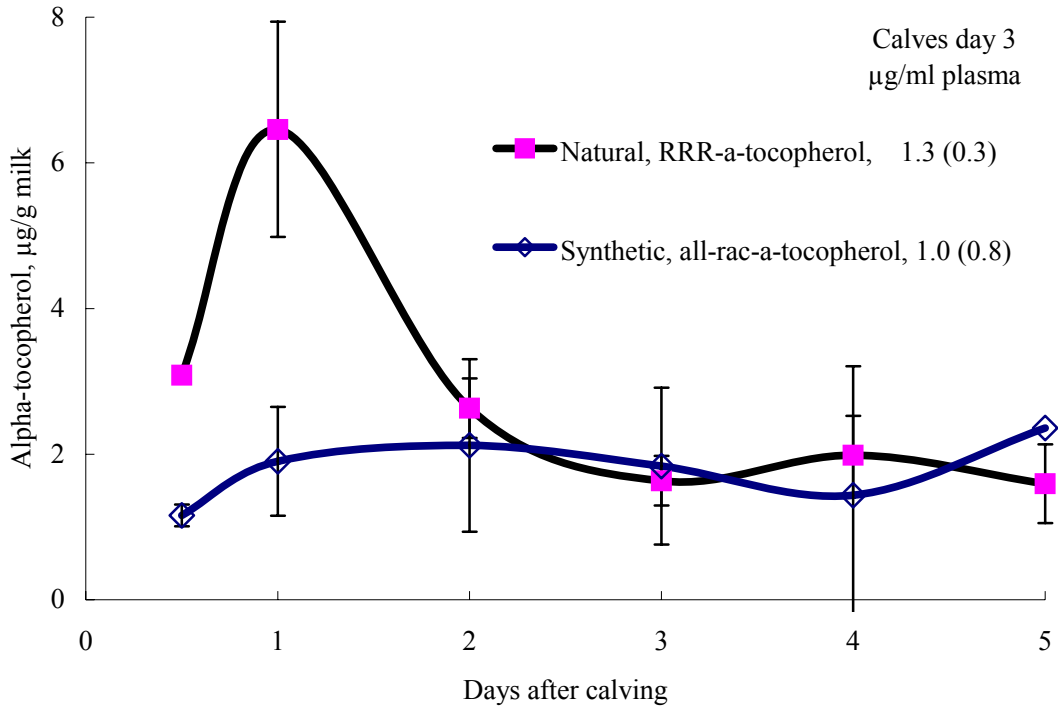


Figure 1 α-Tocopherol concentration in colostrums of cows fed 600 IU per day of either natural or synthetic vitamin E from 7 days prior to calving and until 4 days post partum.

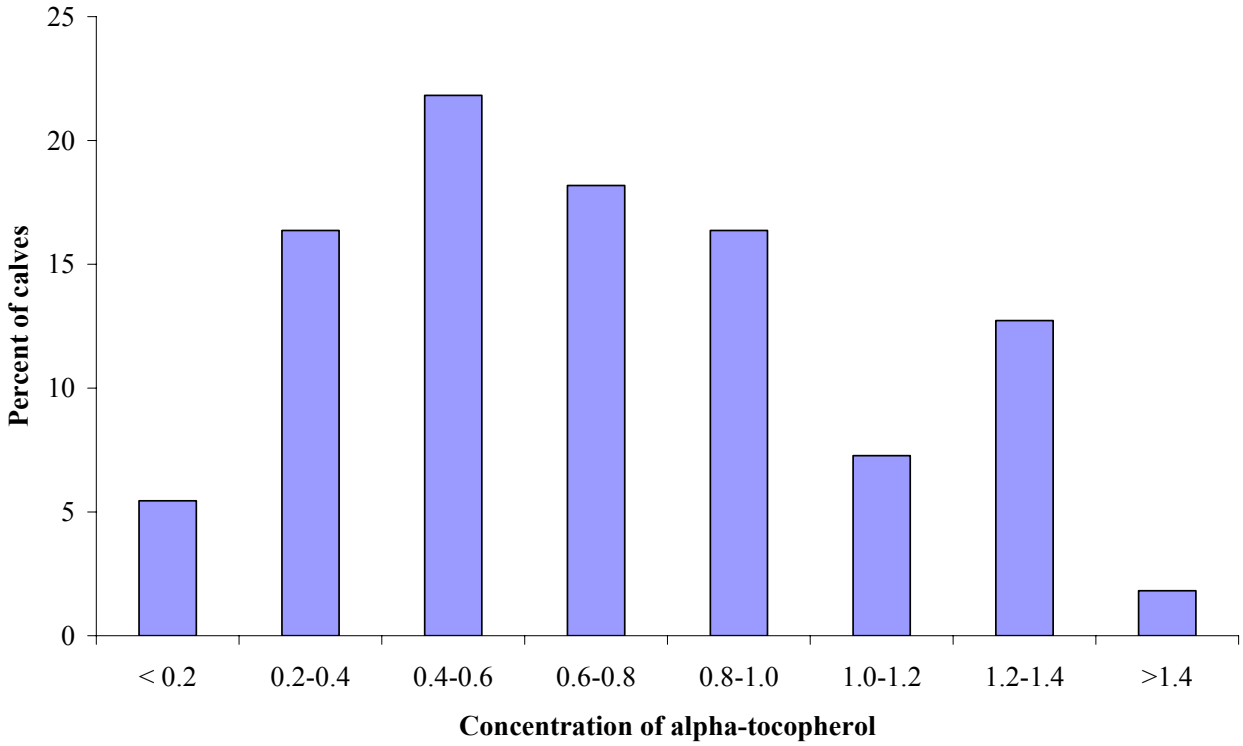


Figure 2. Proportion of calves, age 1-69 days, with different α-tocopherol levels in plasma from eight different organic herds fed cow milk containing 8-10 mg α-tocopherol per kg DM. N= 55.

All calves in the investigation were fed cow milk due to the organic regulations. However, cow milk alone is not capable to secure a high vitamin E level among calves, as more than 80% of the investigated calves had plasma levels of α-tocopherol less than 1 µg/ml plasma, which is considered to be deficient and all calves had α-tocopherol levels less than 1.5 µg/ml plasma, which is considered to marginal deficient (Knudsen et al., 2001).
In figure 3 plasma concentration of α-tocopherol in calves fed milk replacer and concentrate both containing synthetic vitamin E is shown (for experimental details see Sehested et al., 2007, this volume; the curve represent average value of both treatments). Calves were fed 4.74 kg milk/d from day 4 to 14 and 6.60 kg milk/d from day 15 to 49 and 3.30 kg/d until weaning at day 56. Plasma concentration of α-tocopherol increased from 1.8 µg/ml at day 7 to 3.3 µg/ml at day 21, where after it decreased to 1.0 µg/ml at day 63.

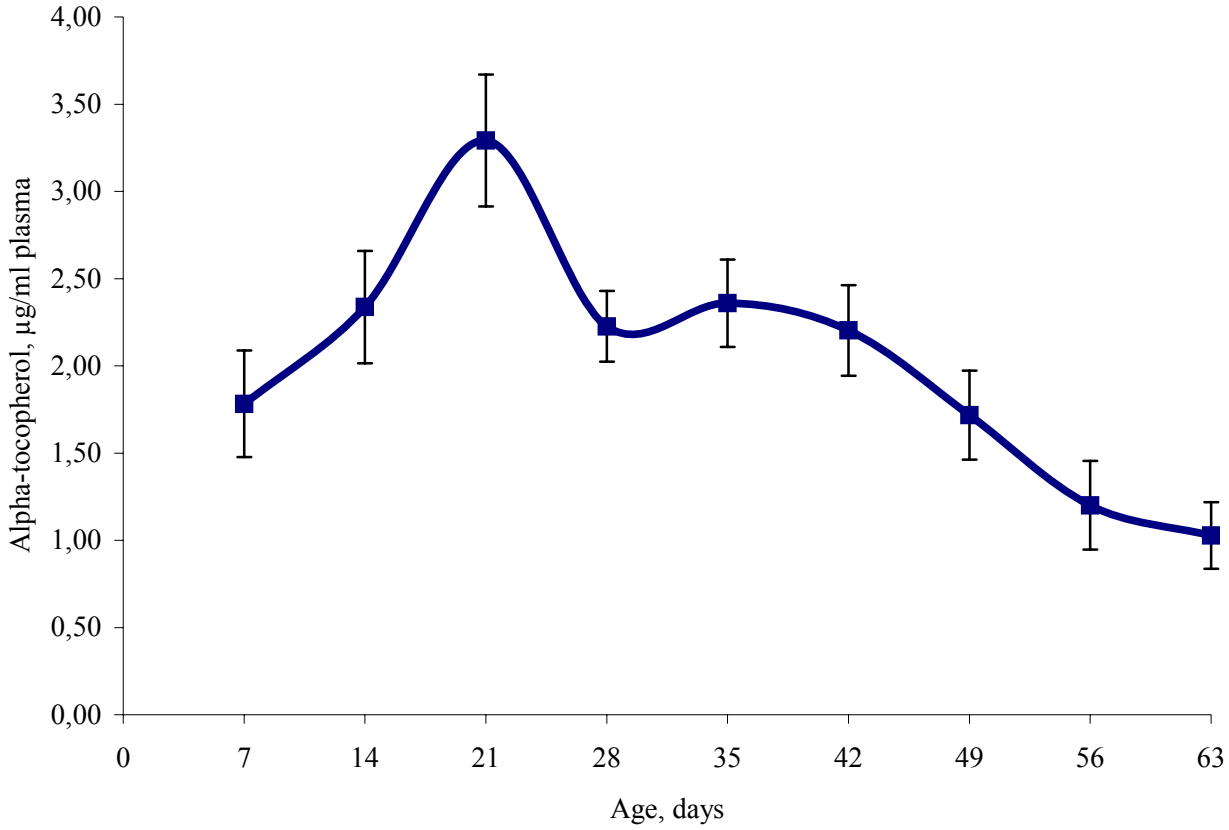


Figure 3. α-Tocopherol concentration in plasma of eight calves fed milk replacer (Friska Sød, DLG, Copenhagen, Denmark) containing 300 mg all-*rac*-α-tocopheryl acetate per kg DM and starter diet containing 50 mg all-*rac*-α-tocopheryl acetate per kg DM.

In figure 4 the distribution of the α-tocopherol stereoisomers in plasma is shown. The natural stereoisomer (RRR-α-tocopherol) constituted 49-57% of the circulating α-tocopherol although it only constitutes 12.5% of the synthetic α-tocopherol. On the other hand the 2S forms of α-tocopherol, which constitutes 50% of the synthetic α-tocopherol does only account for 2-6% of the circulating α-tocopherol, while the three synthetic 2R-stereoisomers each make up 10-17% of the plasma α-tocopherol close to the 12.5% proportion of the synthetic α-tocopherol.

Sehested et al. (2004) raised α-tocopherol content in plasma by cow milk fed calves from 0.6 µg/ml plasma in 1 week old calves to 6.8 µg/ml plasma in 5 week old calves fed 500 IU RRR-α-tocopherol with the milk, while control calves maintained the low level. Further, it was

found that the vitamin E group responded earlier to an tetanus vaccination than the control group. did

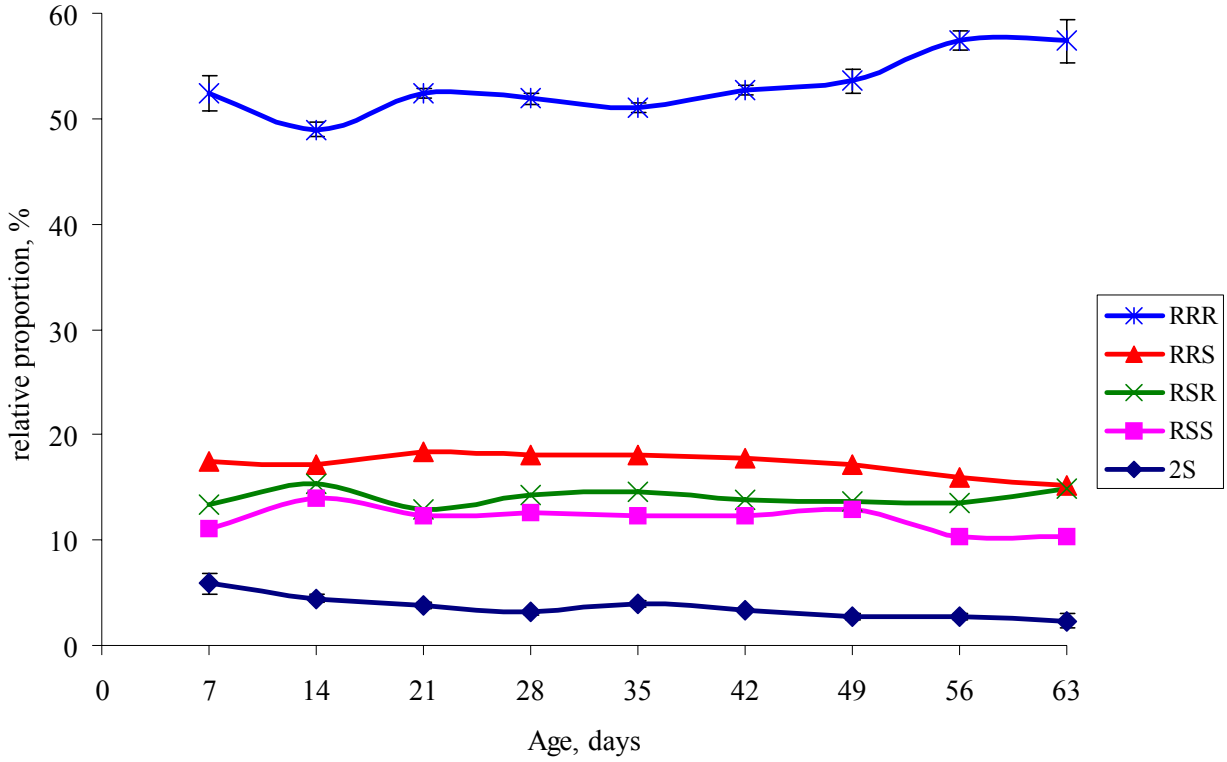


Figure 4. Relative proportion of stereoisomers of α-tocopherol in plasma from calves fed synthetic α-tocopherol.

1.3.5 Conclusions

In conclusion transfer of vitamin E from cow to calf via the milk will rely on the vitamin E status and supply of the cow. The majority of the calves fed cow milk will have a relatively low vitamin E status and in experiments it has been shown that the maturation of the immune system is faster in calves with a high vitamin E status. RRR-α-tocopherol seems to be utilized more efficient than the other stereoisomers as it is more abundant in plasma than expected when calves are fed synthetic vitamin E

1.3.6 Literature

Jensen, S.K and Lauridsen, C. (2007). α-Tocopherol stereoisomers. Vitamins and Hormones 76: 279-306.

Jensen SK, Nørgaard JV & Lauridsen C 2006. Bioavailability of α-tocopherol stereoisomers in rats depends on dietary doses of *all-rac*-a-tocopheryl acetate or RRR-a-tocopheryl acetate. Br J Nutr 95, 477-487.

Knarreborg, A., Lauridsen, C., Engberg, R.M. & Jensen, S.K., 2004. Dietary antibiotic growth promoters enhance the bioavailability of a-tocopheryl acetate in broilers through mediations of the lipid absorption processes. J. Nutr. 134, 1487-1492.

Knudsen, B. S., Kermansen, J. R., Jensen, S. K., Kristensen, T., and M. O. Nielsen. 2001. E-vitamin til malkekøer – forekomst og funktion samt vitaminstatus og sammenhæng til

hyppigste produktionssygdomme i økologiske besætninger. [In Danish]. DJF report Husdyrbrug no. 27, Danish Institute of Agricultural Research, Tjele, Denmark.
Lauridsen, C., Hedemann, M.S. & Jensen, S.K. 2001. Hydrolysis of tocopherol and retinyl esters by porcine carboxyl ester hydrolase is affected by their carboxylate and bile acids. Journal of Nutritional Biochemistry 12, 219-224.
Jensen, S.K and Lauridsen, C. 2007.α -Tocopherol stereoisomers. Vitamins and Hormones 76: 279-306.
Lauridsen, C. & Jensen, S.K., 2005. Influence of supplementation of all-rac-alpha-tocopheryl acetate preweaning and vitamin C postweaning on alpha-tocopherol and immune responses of piglets. J. Anim. Sci. 83, 1274-1286.
Lauridsen, C & Jensen, SK 2007. Transfer of vitamin E in milk to the newborn. Ch. 47 in: The Encyclopedia of Vitamin E (Ed: VR Preedy & R Watson) Wallingford, Oxfordshire, UK : CABI International, 530-538.
Meglia, G.E. Jensen, S.K. Lauridsen, C. & Waller, K.P. 2006. α-Tocopherol concentration and stereoisomer composition in plasma and milk from dairy cows fed natural or synthetic vitamin E around calving. J. Dairy res. 73, 227-234.
Sehested, J., Jørgensen, C., Mortensen, S.B., Jensen, S.K., Vestergaard, M., Koch, P., Jungersen, G. & Eriksen, L., 2004. Effect of oral α-tocopherol and zinc on plasma status, IGF-I levels, weight gain and immune response in young calves. J. Anim. Feed Sci. 13, suppl. 1, 609-612.
Sehested, J., Vestergaard, M., Kristensen, N.B. and Jensen, S.K. 2007. Effect of starch substitution in starter concentrate on ruminal pH and growth in young calves. (This Volume)

1.4 Genetic effects on calf survival

Torstein Steine
Geno, Norway

1.4.1 Abstract

Calving difficulties and still births has a very low frequency in Norwegian Red, and also in Swedish Red, while in most dairy cattle breeds these traits have shown a negative trend over the last years. Crossbreeding with NR or SR improves these traits a lot. There is a genetic background for the negative development, but it does not seem to be explained by one single trait or factor.

1.4.2 Sammendrag

Kalvingsvansker og dødfødsler har en svært låg frekvens i NRF og SRB. De fleste store mjølkerasene i verden har hatt en negativ trend for disse egenskapene de siste åra. Innkryssing med NRF eller SRB gir stor forbedring av disse egenskapene. Det er en viss arvelig bakgrunn for den negative utviklinga, men det lar seg ikke forklare med en enkelt egenskap eller faktor.

1.4.3 Introduction

Calf survival has gained increasing focus over the last decades as a result of the trends in most dairy breeds. There is a clear development of more stillbirths and more calves dying shortly after birth as a result of being very weak.
Holstein, which is the dominant dairy breed in the world, shows a very high rate of stillbirths, and it has been partly explained as an effect of increasing inbreeding and more genetic defects like BLAD and CVM. The negative effect of loosing calves has become very large as the female fertility in most dairy breeds has declined over the last years, and the combination of long calving intervals and large calf losses has caused problems with replacements in the herds. In addition also many herds struggle with reduced longevity of the cows, and early culling of cows makes the replacement situation even worse.

1.4.4 Results

The Norwegian situation
Norwegian Red has a very low frequency of calving difficulties and still births. In contrary to most breeding programs the frequency of calving problems has not changed in the period with data, from 1978. The frequency of stillbirths is 3% at first calving and 1.5% for later calvings and has also remained unchanged since 1978. The level of difficult calvings is 2-3% for heifers and 1% for cows.
Both traits are included in the breeding objective. They have a low weighting in the Total Merit Index because they are not at all regarded to be any problem.

The role of genetics

Heritabilities of calving ease and still births are generally low, most of the reported estimates are below ore close to 0.1 (Heringstad et al, 2007). This is mostly due to low frequencies and limited ability to record it in other ways than as 0 – 1. Therefore genetics does not seem to play an important role for these traits. But still there is a very clear trend in many breeds towards more calving difficulties and more stillborn calves. How is that to be explained?

There are two possible reasons for such a development:

1. Inbreeding.
2. Selection for traits causing negative effects on calving ease and stillbirths.

In some populations there is some inbreeding, but even though the average relationship between animals is very high, the inbreeding rate is not that high yet. It is more a risk of inbreeding or already a high inbreeding rate.

Indirect effects of selection is a very likely reason, but it is hard to find which trait under selection may give these negative results for the calving traits. So far no trait has shown up as the major reason.

Normally there has been a strong correlation between calving difficulties and stillbirths. This relation seems also to have become weaker over the last years meaning that a larger number of stillborn calves have had an easy birth. This is also very strange in a situation with increasing frequency of both calving difficulties and stillbirths.

In Sweden there has been done a study on causes of stillbirths in Swedish Holstein calves, Berglund et al (2003). The calves were examined post mortem in order to find the reason for stillbirth. The results show that one third of the calves seemed clinically normal with no obvious reason for death. But a number of these calves had a low birth weight. The conclusion is that the cause of stillbirths is likely to be multifactorial, and difficult calvings explain only about half of the stillbirths.

Crossbreeding

As most of the problems with stillborn calves and calf survival are reported from countries with very large herds, herd size and herd management has been regarded as major factors.

But the results from crossbreeding in some of these large herds clearly show that there are genetic causes independent of herd size.

Table 1**.** Calving difficulty and stillbirths for breed of sire for first-calf pure Holstein dams. (from B. Heins, 2007)

Breed of sire	Number of births	Calving difficulty %	Stillbirth %
Holstein	371	16.4	15.1
Scandinavian Red (SR and NR)	855	5.5	7.7

Table 2. Calving difficulty and stillbirths for breed group of dam at first calving.
(from B. Heins, 2007)

Breed of dam	Number of births	Calving difficulty %	Stillbirth %
Holstein	676	17.7	14.0
Scandinavian Red (SR and NR)	264	3.7	5.1

The results in Table 1 and 2 show that if Holsteins are mated with Swedish Red or Norwegian Red sires the frequency of stillbirths and calving difficulties get remarkably lower in Holstein herds in California. The same is the effect of including these breeds in the dams as a cross with Holstein. This is an evidence for the fact that the main reasons for the differences in calving difficulties and stillbirths between countries and populations are breed differences or in other words genetic reasons.

Based on these results it is very obvious that crossbreeding is a good tool for improving these traits in Holstein or other breeds, but only if breeds with good additive levels for the traits are chosen for the crossing. Crossbreeding has two advantages. It removes existing inbreeding and allows for including the effect of higher genetic merit for the trait from other breeds.

Calf survival after birth
When the rate of stillbirths is high, it also seems to be the case that a high number of the calves are weak and low apetite. The probability of more calf losses in such situations is therefore high. In many countries, especially with Holstein and Jersey, calf losses, including stillbirths, on 20% or more is reported.
In Norway the loss after birth is reported to be at around 2-3% so that the total calf loss is below 6%. It has been reported more calf loss when herd size is increasing. This is apparently an effect of herd management or most likely an effect of technical solutions that do not function very well.

1.4.5 Discussion and conclusions

All available evidences show that genetics is an important factor when stillbirths and calving ease show a negative genetic trend over many years, as they do in some of the major dairy cattle breeds in the world. It is, however, not so obvious how to change the selection in order to make these traits move in a desired direction. It has something to do with increasing inbreeding, but also with incomplete breeding objectives. It may also have something to do with fast genetic change in milk yield, though it is not possible to show it with genetic correlations between the traits. One possibility is that the cows with the highest genetic merit for milk production have got some changes in the way available energy is used. With a small shortage of energy it may have dramatic consequences if energy for milk production has a higher priority than energy to the almost fullborn calves.
Norwegian Red seems to be a breed with a somewhat special situation, partly the same as Swedish Red. That may be a result of a long time history of selection for many traits,

including calving traits and health traits and with less focus on milk production than any other breeding program in dairy cattle.
To make the situation better in the worst breeds the breeding objectives must change, but they must also be allowed to work, both with regard to data, population structure to handle low heritability traits and time. In dairy cattle such a major change in the breeding program with needed changes in the traits will take 30 – 40 years. Therefore crossbreeding is the best choice for many farmers, but it is still needed to improve the existing breeding programs in many cases. Otherwise too much of the future genetics in dairy cattle may come from only a few sources.

1.4.6 Literature

Berglund, B., L. Steinbock and M. Elvander. 2003. Causes of Stillbirth and Time of Death in Swedish Holstein Calves Examined Post Mortem. Acta Vet Scand. 44: 111-120.

Heins, B. 2007. Impact of an Old Technology on Profitable Dairying in the 21st Century. 4th Biennial W. E. Petersen Symposium, 7-19.

Heringstad, B., Y.M. Chang, M. Svendsen and D. Gianola. 2007. Genetic Analysis of Calving Difficulty and Stillbirth in Norwegian Red cows. J. Dairy Sci., in press.

1.5 Can we predict the immunity of calves using a colostrum index?

Hanne Solheim Hansen,
Nord-Trøndelag University College, Steinkjer, Norway

1.5.1 Abstract

Colostrum is the most important factor for the immunity, and thus the health of newborn calves. Colostrum given during the first day after birth is particularly important because the immunoglobulins may be absorbed during that period. Therefore it is important to have specific routines securing sufficient colostrum for the calf.

The aim of the present study was to evaluate the possibility of estimating the immunity status of calves (colostrum index, CI) using information about the time of feeding and the quantity and the quality of colostrum given to the calf. Two studies were performed. One study used calves from 3 different farms, 17 calves were allowed to suck their mothers in addition to the colostrum that was given from a bottle. In the other study at only one farm, 11 calves were taken from their mothers at birth and only given colostrum from a bottle, allowing full control of colostrum intake. The time of feeding and the amount of colostrum given was registered. The quality of the colostrum was measured using an immune check kit. Blood samples were taken from each calf before 14 days of age, for measurement of IgG concentration in serum.

We estimated a colostrum index for each calf. There was a significant correlation between the estimated immunity (colostrum index) and the measured concentration of IgG in serum. We conclude that the colostrum index is a suitable method that may be used to estimate the immunity of calves when the routines for colostrum feeding are known. However, more studies are needed to confirm these results before the method can be used in the field.

1.5.2 Sammendrag

Råmelksperioden og spesielt råmelkstildeling i første levedøgn er viktig for kalvens immunitet tidlig i livet, og dermed risiko for å bli syk. Det er derfor viktig å ha gode rutiner for råmelkstildeling, for å sikre nok råmelk til kalven.

Målet med dette arbeidet var å undersøke muligheten for å beregne immunstatus hos kalv når man kjenner tidspunkt for tildeling av råmelk, mengden og råmelkskvaliteten. Dette kalles en råmelksindeks (CI). Det ble gjennomført to undersøkelser. Den første undersøkelsen foregikk på tre gårder med 17 kalver. Kalvene fikk suge moren første døgn og fikk i tillegg råmelk fra flaske. Den andre undersøkelsen foregikk på èn gård med 11 kalver. Disse kalvene ble tatt fra mora rett etter fødsel og fikk råmelk kun fra flaske. Vi har målt innholdet av IgG i råmelk og i serum ved hjelp av Immun Check Kit på laboratoriet.

Ved hjelp av informasjon om tildelt mengde råmelk, kvalitet på råmelk og tidspunkt for tildeling beregnet vi en råmelksindeks for hver kalv. Det var signifikant sammenheng mellom beregnet immunitet og den målte konsentrasjonen IgG i serum. Det tyder derfor på at råmelksindeks kan brukes til å beregne IgG konsentrasjonen i serum og dermed brukes til å

vurdere immunstatus. Det er imidlertid nødvendig med flere studier som kan verifisere disse resultatene før råmelksindeksen kan tas i bruk i praksis.

1.5.3 Introduction

Calves are born without natural immunity. Colostrum is the only source of immunity and nutrients for newborn calves. Colostrum contains several types of immunoglobulins, however, the immunoglobulin G (IgG) comprises more than 85% of the immunoglobulins and is therefore the most important immunoglobuline for the immun status (Barrington and Parish 2001).

During the first 24 hours after birth IgG molecules may be absorbed directly (pinocytose), without being digested first. This ability of the intestine is present only a short period after birth. At most, up to 24% of the immunoglobulins from the colostrum may be absorbed and found in the serum of the calf. (Heinrichs 1997). The ability of the intestine to absorb IgG molecules decrease proportionally with time after birth, and is considered not present after 24 hours (McCoy et al. 1970, Maynard et al. 1979, Heinrichs 1997, Weaver *et al*. 2000, Mowrey 2001).

The amount of immunoglobulins the calf receives is naturally a determining factor for the calves' immunity. The amount of immunoglobulins received is proportional to the amount of colostrum given, and the concentration of IgG in the colostrum. Colostrum is considered of good quality when it contains >50 g/liter (Liberg 2001). In Norway it is recommended to give as much colostrum as the calf wants for the first feeding and up to 2 liters colostrum for all additional feedings.

The immunity of the calf should, theoretically, be proportional to the amount of IgG given, adjusted for the time of feeding since birth. Thus the colostrum index (CI) is a sum of the colostrum given during the first day after birth.

$CI = \sum A*Q*c*e^{-kt}$
CI = colostrum index,
A = amount of colostrum,
Q = quality of colostrum,
c = maximal absorption of IgG (24%, Heinrichs 1997),
$k = \ln(2)/T_{½}$ ($T_{½}$= 12 hours, Heinrichs and Jones 2003)
t = time in hours after birth

The purpose of the present study was to develop and to test the liability of a colostrum index as a tool to estimate the immunity in calves.

1.5.4 Materials and Methods

The materials include results from two studies. One study in which the calves were allowed to receive milk from their mother, thus receiving colostrum directly from the udder in addition to colostrum given from a bottle. In the other study the calves were taken away from the mother at birth and given colostrum only from bottles.

Study 1: Colostrum from mother and bottle. The first study was performed from January to April 2005 (Andersen and Helander 2005). In that study the calves stayed in a pen with their mothers the first day after birth, and received colostrum from sucking. In addition, some of the calves were also given colostrum from a bottle, to ensure that the calves received sufficient colostrum. The amount of milk consumed at each visit was estimated to 0.1 liters/ min they were sucking. That study was performed at 3 different dairy farms and included 20 calves. The sucking behaviour of the calves was observed the first day after birth, and samples of colostrum were collected for measurement of IgG content. Before each calf was 14 days old a blood sample was taken to measure IgG levels in serum.

Study 2: Colostrum from bottle only. This study was performed at one dairy farm, from September to November 2006 (Tyrina and Povarova 2007). After birth the calves were taken into an individual pen. Each calf was given up to 8 liters of colostrum during the first day after birth following three different feeding schedules. Colostrum and blood samples were taken from the calves to measure IgG levels.

Samples of colostrum were taken from the first milking, and 30-50 ml. was frozen immediately. Later, the samples were thawed in room temperature before a sub sample of 2 ml. was taken and frozen. Those samples were later sent to the laboratory for analysis of IgG content.

Blood samples were taken with Vacutainers with no additives. After the blood had coagulated the samples were centrifuged for 20 min at 5000 rpm to extract the serum. Then ca. 2 ml. of serum was taken into another vial and frozen until all samples were sent to the laboratory for analysis of IgG.

Analysis of IgG in colostrum and serum was performed at the Mastites Laboratory in Molde, Norway using Immun Check kit, SRID (Single Radial Immuno Diffusion) from VMRD Inc. USA. The SRID methodology involves the use of a gel that contains IgG antiserum. The content of IgG from the samples reacts with the antiserum of the gel and forms visible rings. The size of the rings are proportional to the amount of IgG in the sample. The same gel is used for colostrum and serum. The colostrum is diluted with a physiological salt solution, while the serum samples are analysed without dilution.

To compare the immunity of the calves, the content of IgG was extrapolated back to the level of IgG at day one after birth using the following formula.

$$A = \frac{Y}{e^{(-k \cdot t)}}$$

A = [IgG] at day one after birth

Y = [IgG] at the day the blood sample was taken

t = time in days after day one after birth

k = ln (2)/$T_{½}$, $T_{½}$ = 21 days (Mowrey 2001).

1.5.5 Results and discussion

In the two studies there was a great difference in how quickly the calves received colostrum after birth. In the study where the calves could suck their mothers, the calves received the first colostrum between 1 and 12 hours after birth (Table 1), however only one calf waited 12

hours to get colostrum and all other calves got colostrum between 1 and 6 hours after birth. In the other study the colostrum routines were predetermined and the calves received colostrum as quickly as 30 min after birth and only one calf waited until 7 hours after birth to get the first colostrum.

Estimated amount of colostrum consumed by the calves allowed to suck their mothers was 5.26 liters while the calves fed only bottled colostrum consumed 6.27 liters (Table 1). Colostrum consumption of more than 6 liters the first day is considerable, and demonstrates successful colostrum routines.

The colostrum from the study where the calves only received bottled colostrum was of very good quality. Average concentration of IgG was 78 g/liter, and only 2 samples were below 50 g/liter. Colostrum quality averaging 78 g IgG/liter is very good, and the calves at this farm have a possibility of getting good immunity. The quality of colostrum in the other study was lower and showed larger variation (Table 1), and 16 out of 17 samples were below 50 g/liter. A considerable variation in colostrum quality between farms is in accordance with results from other field studies (Gulliksen 2006).

The immunity status of calves in study 1 was on average 24 g IgG/liter serum (Table 1). The immunity status was poor (< 10 g/liter serum) for 3 calves, medium (10-16 g/liter) for 5 calves and good (> 16 g/liter) for 12 calves. In the other study only 1 calf had medium immunity status and 10 had good immunity status. These results demonstrate a somewhat better immunity status compared to results from a previous field study in the region, where 60% of 746 calves had poor immunity (Nybø et al. 2003).

Table 1. Number of calves, colostrum quality and average immunity of calves in the two studies

	Study 1. Cow and bottle	Study 2. Bottle
Number of calves with all required registrations and analysis	17	11
Time of first feeding	1-12 hours	30 min-7 hours
Amount of colostrum given, Liter/calv	5.26±2.57	6.27±1.18
Average IgG in colostrum, g/liter	36.7±18.0	78.08±8.51
Average IgG in serum, g/liter	24.3±18.0	31.5±10.6

A simple regression analysis was used to analyse possible correlation between estimated immunity, CI, and measured immunity of the calves (Fig 1). Regression analysis resulted in the following relation:
CI = 17.8 +0.81* measured immunity

Measured and estimated immunity was significantly correlated (p= 0.0014), demonstrating that the immunity can be estimated when the time of feeding and the amount and quality of colostrum is known. The estimated immunity was, however, quite variable when comparing a certain level of measured immunity, demonstrated also by $R^2 = 0.33$. With the limited amount of data collected so far, a few out-laying points will affect the estimated regression substantially. Therefore more data is needed to improve and verify the CI.

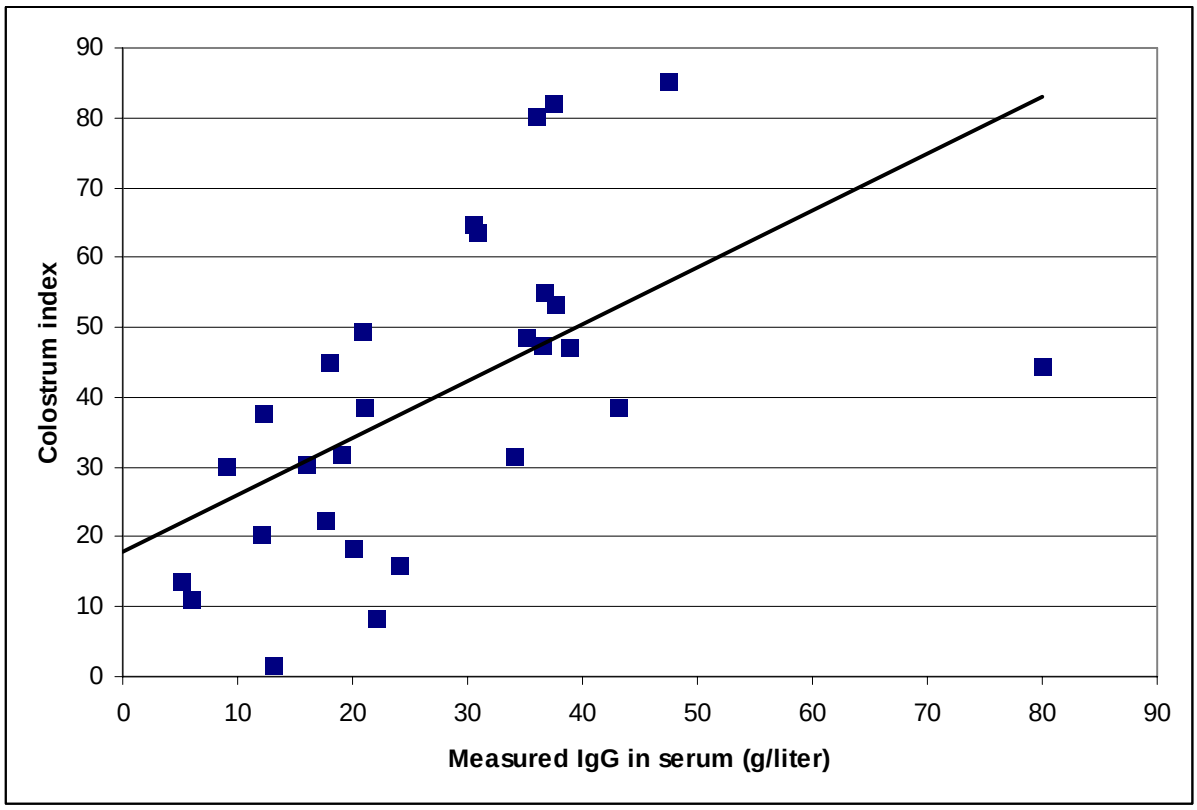


Fig. 1. Estimated colostrum index and measured IgG in serum of 28 calves, of which 17 calves were allowed to suck their mothers in addition to getting colostrum from bottle and 11 calves were given colostrum from bottle only.

1.5.6 Conclusions

The present study has given further documentation for the variation in quality of colostrum between farms, and also the variable routines applied for colostrum feeding. At some farms the immunity of the calves are low or medium, while some manage to achieve good immunity for their calves. The estimated immunity using CI was significantly correlated to the measured immunity from blood sample, suggesting that the immunity may be estimated when the time of feeding and the amount and quality of the colostrum is known. However, further studies are needed to document the validity of the colostrum index.

1.5.7 Literature

Andersen, B. M.and M. Helander. 2005. Immunity and behaviour of calves used with their mothers the first day after birth. Bachelor thesis, Nord-Trøndelag University College

Barrington, G. M. and S. M. Parish. 2001. Bovine neonatal immunology. In The veterinary clinics of North America. R. A. Smith (ed).

Gulliksen, S. 2006. ”Kalveprosjektet”. Helsetjeneste for storfehelsenytt.

Heinrichs, A. J. 1997. Feeding the newborn dairy calf. PennState Special Circular 311. http://www. das.psu.edu/dcn/calfmgt. Oppdater 08.97 Hentet 04.09.02

Liberg, P. 2001. Routines for feeding colostrum. Råmjölksutfordring – ”En god start forlanger livet”. VMD, Ibst. För husdjurens miljö och helsä, SLU

Maynard, L. A., Loosli, J. K., Hintz, H. F., Warner, R. G. 1979. Animal Nutrition, Seventh Edition. McGraw-Hill Book Company.

Mowrey, C. M. 2001. Influence of feeding pooled colostrum or colostrum replacement in IgG levels and evaluation of naimals plasma as a milk replacer protein source. Master thesis, Virginia polytechnic Institute and State University. http://scholar.lib.vt.edu/theses/available/etd-05112001-122629/unrestricted/etd_cmm.pdf read May 2007

McCoy, G. C., Reneau, J. K., Hunter, A. G., Williams, J. B. 1970. Effect of diet and time on blood serum proteins in the newborn calf. J Dairy Sci. 53: 358-362.

Nybø, K., Malmo,T., Simensen, E. 2003. Råmelk og immunitet. BUSKAP 7 34-36.

Tyrina, A. and Povarova, T. 2007. Verification of a colostrum index. Bachelor thesis, Nord-Trøndelag University College

Weaver, D.M., J.W. Tyler, D.C. VanMetre, D.E. Hostetler, and G.M. Barrington. 2000. Passive transfer of colostral immunoglobulins in calves. J. Vet Intern Med. 14:569-577.

2 Health

2.1 Health status of calves in North America and Scandinavia

Kenneth E. Leslie and Cynthia G. Todd
Department of Population Medicine, University of Guelph, Guelph, Ontario, Canada, N1G 2W1

2.1.1 Abstract

Morbidity and mortality of young dairy calves due to calving difficulties, neonatal calf diarrhea complex, bovine respiratory disease, joint-ill, umbilical infections and septicaemia are common in most dairy regions of the world. The incidence rates and risk factors for these conditions vary widely between regions. This manuscript reports a synopsis of the rates and the risk factors that have been published concerning the health status of young dairy calves.

2.1.2 Sammendrag

I hele verden får kalv helseproblem eller dør på grunn av kalvingsvansker, diaré, luftveissykdommer, navle- og leddbetennelser eller blodforgiftning. Forekomst og risikofaktorer for hver av disse helseproblemene variere mellom ulike regioner. I denne artikkelen har vi, med utgangspunkt i publiserte artikler, sammenstilt risikofaktorer og forekomst av disse helseproblemene hos unge kalver.

2.1.3 Introduction

Successful raising of dairy calves is a challenge. Around the world, dairy producers often struggle with keeping their young calves healthy. The high-risk period for calf morbidity and mortality occurs during the first three weeks of life (Waltner-Toews *et al.*, 1986; Curtis *et al*., 1988; Wells *et al*., 1996). This neonatal period is the critical time in the life of a dairy calf, when they are adapting to a new environment and facing exposure to several disease-causing pathogens. In addition, the adaptive immunity of neonatal calves has not yet been established. Thus, newborn calves are reliant on maternal immunoglobulins in colostrum for protection against infectious disease. Several management, environmental, and nutritional factors influence calf morbidity and mortality. The aim of this paper is to summarize our knowledge of the health status of dairy calves, with particular emphasis on reports from North America and Scandinavia. Incidence rates for the major diseases of neonatal dairy calves will be described. Finally, known management practices and other risk factors for dairy calf morbidity and mortality will be discussed.

2.1.4 Results and discussion

Success of the Calving Event
Dystocia and stillbirths have become a major concern to the dairy cattle industry. Stillbirth is defined as delivery of a dead calf or a calf that is born alive but dies within the first 24 hours of life. Various studies have documented the actual rates for stillborn calves. Most reports

suggest that between 10% and 20% stillbirth in first calf-heifers, especially in the Holstein breed. It is also clear that this problem exists on a worldwide basis. Both stillbirth and dystocia have significant impacts on calf survival and cow performance. These impacts are both direct (i.e. loss of animal, increased veterinary care costs) and indirect (i.e. impaired milk production and reproductive performance). The success of this event depends on a variety of factors, both at the cow level and the herd level.

A large observational trial was recently conducted in Canada to investigate the farm level risk factors associated with stillbirth. The main data collection tool was a questionnaire that focused on the calving facilities and standard operating procedures for calving on the dairy operation. A total of 162 dairy producers from Ontario and western Canada agreed to participate in this study. Milk production, reproduction and culling data from these farms, for the years 2002-2005, was collected from the CanWest DHI database system. The mean herd-level incidence of stillbirth for cows calving in 2004 and 2005 was 7.6%. Interestingly, the herd-level incidence ranged from 0% to 17.3%. The frequency of observation of the calving cow/heifer (both in late gestation and in the early stages of labour) had a very significant association with the delivery of a live calf. In this study, the use of a video camera system was associated with a 44% increased rate of live calves being born. Clearly, the timing of any assistance given to the cow was crucial to the success of the calving event. Producers in general, are knowledgeable and well-prepared to give assistance. Thus, it is important and helpful that there is knowledge of when to initiate calving assistance. Excessive body condition in pregnant heifers was associated with an increased risk of stillbirth. This was potentially due to feeding a diet that was too nutritionally dense, and subsequent excessive fat deposition in the birth canal, which in turn would restrict or complicate passage of the calf. However, grouping of first-calf animals with mature cows, as well as having individual versus group calving pens, did not have a significant association with the occurrence of stillbirth. On the other hand, summer pasture was associated with an increased risk of stillbirth. This association is most likely due to a reduction in the frequency of observation of these animals compared to cattle that are more intensively housed, rather than simply that the cattle had actual exposure to the outdoor environment.

As expected, there was a significant production decrease in the first test day production for both cows and heifers that delivered a dead calf. At the first test day, first lactation animals that had a stillborn calf produced 0.9 kg/day less than first lactation animals that had delivered a live calf. Mature cows that delivered a dead calf produced 2.4 kg/day less than mature cows that had delivered a live calf. At the second test day, the occurrence of a stillbirth has approximately two times the effect (but a smaller absolute value) on mature cows than it did on first lactation animals. This difference between first lactation animals and mature cows remained consistent in the 305D milk production records. The occurrence of a stillbirth at calving was associated with an increased number of days open (OR=1.17), which has both biological and economical significance to the producer. Interestingly, there was no significant association between the occurrence of stillbirth and the risk of being culled, during or at the end of lactation.

A few studies have examined the behavioural changes that occur in periparturient cows. In the 12 hours before calving, cows show an increase in semi-lateral recumbency, as well as an increase in the frequency of lying down and standing, with short duration of standing and lying bouts. Cows that show prolonged restlessness, cessation of labour or lack of appearance of the calf's feet are more likely to present with a difficult delivery. Also, the calves born during difficult deliveries take longer to stand, and subsequently nurse. Preliminary research in Colorado has examined the effects of dystocia on subsequent calf health. Calves born during a difficult calving had a higher rate of morbidity and mortality from neonatal calf disease.

Table 1. Available figures for abortion, stillbirth and neonatal death in dairy cattle from Denmark, Finland, Norway and Sweden (%) (Osteras, et al. 2006).

Country	Denmark	Finland	Iceland	Norway	Sweden
Year presented	2006	2005	2005	2006	2005
Calvings (n)	586380	356064	24000	284778	392000
Aborted	-	4279 (1.2)	-	1708 (0.6)	(0.6)
Born Dead	45737 (7.8)	16692 (4.7)	-	8043 (2.8)	(3.6)
Dead before ID	-	2276 (0.7)	-	2574 (0.9)	?
Dead < 30d	26492 (4.9)	-	-	1907 (0.7)	-
Dead 1-90 d	-	-	-	4359 (1.6)	(3.1)
Dead 1-180d	45954 (8.5)	9135 (2.5)	-	5722 (2.1)	(4.0)

Success of Colostrum Management Programs

The success of passive transfer of maternal immunoglobulins, and the colostrum management program, can be monitored by using refractometry to measure serum total solids (TS) concentrations. Failure of passive transfer is usually defined as a TS concentration of less than 5.2 g/dL. Recently, a large-scale research effort was completed to determine the levels of passive immunity, as measured by serum TS concentrations, in 422 calves up to one week of age on 116 southern Ontario dairy farms (Trotz-William *et al*, 2006) (Figure 1.). In this study, 39.8% of calves showed failure of passive transfer (FPT). Several management factors were significantly associated with calf serum TS concentrations.

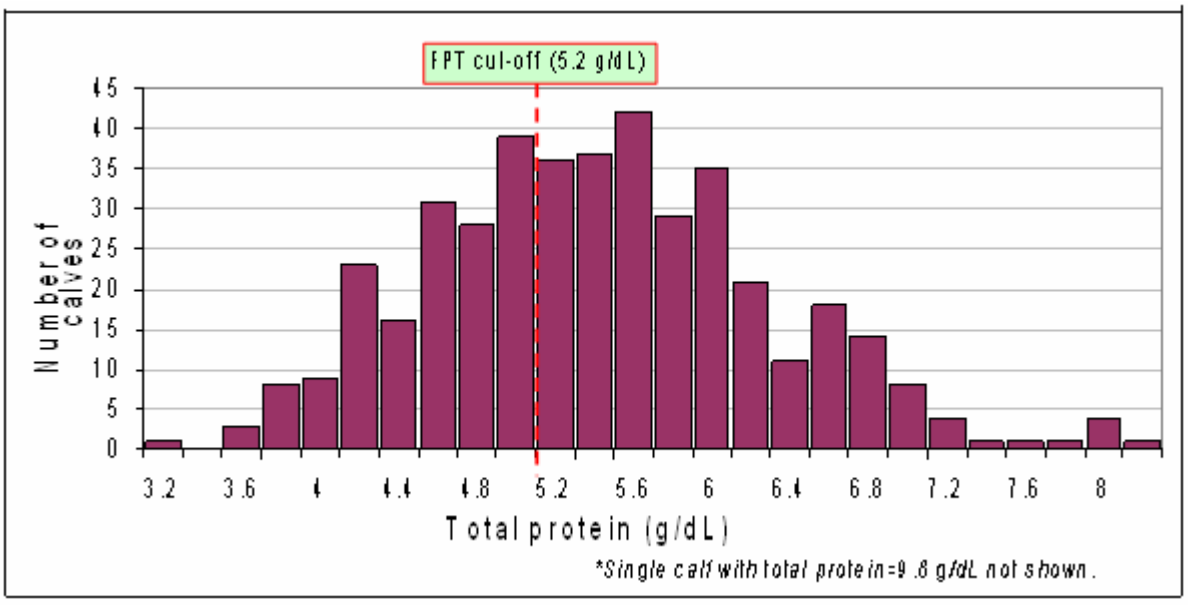


Figure 1: Refractometry results for 422 calves on 116 southern Ontario dairy farms. (Trotz-William et al., 2004)

Neonatal Calf Disease

The major health problems of young dairy calves include neonatal calf diarrhea complex, respiratory disease, umbilical infections, joint problems and septicemia. Several large-scale studies have described the incidence risk, and calf mortality, for these common calfhood

diseases (Waltner-Toews *et al.*, 1986; Curtis *et al*., 1988; Wells *et al*., 1996; Donovan *et al*., 1998; NAHMS, 2002; Svensson *et al*. 2003) (Table 1).

Table 1: Incidence risks for mortality, diarrhea, respiratory disease, umbilical and joint problems, and septicemia in dairy calves.

	Incidence Risk (%)					
	Study Period	Mortality	Diarrhea	Respiratory Disease	Umbilical/ Joint Problems	Septicemia
Waltner-Toews et al. (1986)	**pre-weaned**	3.76 %	20.5 %	15.4 %	not reported	not reported
Virtala et al. (1996)	**0 - 3-mths**	5.6 %	28.8 %	17.3 %	0.002 to 15.1 %	not reported
Donovan et al. (1998)	**0 - 6-mths**	11.7 %	35.0 %	21.0 %	11.0 %	24.0 %
NAHMS (2002)	**pre-weaned**	8.7 %	not reported	not reported	not reported	not reported
Svensson et al. (2003)	**0 - 3-mths**	3.0 %	9.8 %	7.0 %	0.6 - 13.0 %	not reported

Diarrhea and Other Digestive Tract Disease

The main diarrhea-causing pathogens include enterotoxigenic *Escherichia coli* (ETEC) K99 (F5), *Salmonella*, rotavirus, coronavirus, and *Cryptosporidium parvum*. Calves are at highest risk of ETEC K99 (F5) diarrhea during the first few days of life. Salmonellosis can occur in calves throughout the neonatal period and is often associated with a high mortality rate. Viral infections and cryptosporidiosis are very common in calves and typically occur between one and three weeks of age. In addition, it is well recognized that outbreaks of calf diarrhea are usually associated with more than one pathogen (Constable, 2004).

As described above, there are several pathogens that can cause disease in young calves. Neonatal calf diarrhea complex is a leading cause of disease in young calves. A major focus of the University of Guelph dairy research program has been on neonatal calf diarrhea complex and cryptosporidiosis in calves. *Cryptosporidium parvum* is an important zoonotic pathogen among dairy calves. A prevalence study conducted in southwestern Ontario during 2002 indicated that approximately 41% of dairy calves (n=500) between 7 and 21 days of age were shedding *C. parvum* oocysts in the feces (Trotz-Williams *et al.*, 2005_a). The within-herd prevalence of cryptosporidiosis was highly variable, as zero to 70% of dairy calves on the study farms were shedding *C. parvum* oocysts. Furthermore, calves shedding *C. parvum* were three times more likely to present with clinical signs of diarrhea.

Two follow-up studies were conducted to investigate calf-level risk of *C. parvum* shedding and diarrhea, as well as farm characteristics and management practices associated with within-herd prevalence of cryptosporidiosis (Trotz-Williams et al., 2007_a; Trotz-Williams et al., 2007_b). In the calf-level risk factor study (Trotz-Williams et al., 2007_a), 78% of calves less than 30 days of age were detected as shedding *C. parvum* (n=1045 calves from 11 farms). The within-herd prevalence of *C. parvum* shedding ranged from 35% to 100%. Calf factors significantly associated with *C. parvum* infection included feeding of milk replacer, maternity

pen facilities and calf scour prophylaxis in cows. Furthermore, factors associated with diarrhea in calves included season of birth, shedding of *C. parvum* oocysts, intensity of *C. parvum* shedding, time to separation from dam, and colostrum source (Table 2).

In the herd-level risk factor study (Trotz-Williams et al., 2007_b), 30% of calves were shedding *C. parvum* oocysts in the feces and at least one positive calf was detected on 77% of the study farms (n=1089 calves from 119 herds). The within-herd prevalence of *C. parvum* infection ranged from zero to 80%. Factors that were significantly associated with increased risk of cryptosporidiosis included the use of scour prophylaxis in cows and calves, as well as the feeding of milk replacer during the first week of life. Whereas, concrete flooring in calf housing areas and the use of soap or detergent to wash calf feeding utensils were associated with a reduced risk of *C. parvum* infection.

Table 2: Calf factors statistically associated with *Crypto. parvum* infection and diarrhea

Calf Factor	**P value**	**Nature of association**
Feeding of milk replacer	<0.001	OR=3.98; The odds of *C. parvum* infection was **298% higher** among calves fed milk replacer compared to those calves that were fed milk.
Birth in multi-cow calving area versus individual calving pen	<0.001	OR=0.62; The odds of *C. parvum* infection was **38% lower** among calves born in a multi-cow calving area compared to calves born in individual maternity pens.
Use of calf scour prophylaxis in cows	0.001	OR=0.40; The odds of *C. parvum* infection was **60% lower** among calves born to cows receiving with calf scour prophylaxis compared to those receiving no prophylaxis.
Season of birth	<0.001	OR=1.86; The odds of diarrhea was **86% higher** among calves born in during the summer months compared to those calves born during the winter.
Shedding of *Cryptosporidium parvum* oocysts	<0.001	OR=4.65; The odds of diarrhea was **365% higher** among calves shedding *C. parvum oocysts* compared to those calves not shedding oocysts.
Number of oocysts: high (>$2.16x10^5$) versus low	<0.001	OR=2.64; The odds of diarrhea was **164% higher** among calves shedding a high number of *C. parvum* oocysts compared to those calves shedding low number of oocysts.
Time to separation from dam	<0.001	OR=1.54; The odds of diarrhea was **54% higher** among calves that remained with the dam for greater than one hour after birth compared to those separated within an hour of birth.
Colostrum fed from dam only	<0.021	OR=0.77; The odds of diarrhea was **23% lower** among calves that were fed colostrum taken from their dam compared to those calves fed colostrum from other sources.

Respiratory Disease

Respiratory disease is typically seen shortly after weaning or during the introduction to group housing. However, it can also be a health problem among neonatal calves. Table 1 suggests that 10 to 20% of young calves develop respiratory disease. In a Minnesota study, the case fatality rate for pneumonia was 9% (Sivula et al., 1996). In a 1986 study of 104 herds in Ontario, 2.3% calves were treated each week for pneumonia (Waltner-Toews et al., 1986). Long-term effects of this disease include an increased risk of culling, delayed entry into the milking herd and an increased risk of death (Waltner-Toews et al., 1986). For every month that a calf is delayed in growth past 24 months, there is an estimated loss of $30 per calf per month. In Michigan, producers estimate costs of approximately $14.71 per calf per year due to respiratory disease (Ames, 1997). In a New York state study by Warnick et al (1995), it was reported that calves that had pneumonia were 4 times more likely to die or be culled before starting their first lactation (24% vs. 62% for healthy calves).

Bovine respiratory disease (BRD) in young calves can be caused by a number of viruses, such as infectious bovine rhinotracheitis (IBRV), bovine viral diarrhea (BVD) virus (types 1 and 2), bovine respiratory syncitial virus (BRSV), parainfluenza-3 (PI-3) virus, etc. BRD results from an interaction between infectious agents, environmental stressors and reduced host defenses. Environmental factors that predispose calves to BRD include changing temperature extremes, over-crowding, transportation and poor ventilation. Other factors that contribute to BRD include malnutrition, impaired immune defenses, dehydration, decreased mucociliary clearance from the lung, or inadequate colostral transfer (Bowland and Shewen, 2000). Symptoms of BRD include rapid breathing, loss of appetite, coughing, fever, discharge from the nose and eyes and swelling around the throat and neck. BRD can be fatal in the acute phase. In the chronic phase, BRD has been associated with a significant decrease in height and weight of dairy heifers between birth and six months of age (Donovan et al., 1998).

Traditional approaches to the housing, feeding and general management of dairy calves for the prevention of BRD are often met with lack of success. Although improvements in management of calving, colostrum handling and delivery, minimizing environmental exposure to pathogens, enhanced feeding strategies, and provision of appropriate care to sick calves can be useful, significant rates of disease still often occur. Active immunization should be one of the potential solutions to the problem of BRD in young calves. Yet, with the promotion of effective colostrum management programs, and with success of passive transfer of immunoglobulins, the colostral antibodies against these respiratory agents have an inhibitory effect on the success of active immunization. In other words, it is difficult for young calves to mount an active antibody titre to the major agents of respiratory disease. In a recent study, a combination modified-live 5-way commercially available parenteral vaccine was evaluated for its ability to stimulate protective immunity in calves after intranasal administration (Ellis *et al,* 2007). This study showed that both single and combination BRSV vaccines, administered by the intranasal route, provided clinical protection and a sparing effect on pulmonary tissue, similar to that detected in response to parenteral delivery of combination MLV and inactivated BRSV vaccines previously assessed in the same challenge model.

Joint-ill, Umbilical Problems and Septicaemia:
Joint and umbilical problems are also noteworthy causes of neonatal illness and calf death. Septic arthritis occurs in young calves as a result of a bacterial infection in the joint. The route of infection is often via the umbilicus or umbilical veins. The risk of septic arthritis is quite low, as less than one percent of young calves develop this health problem. However, approximately 10 to 15% of young calves develop umbilical infections (Table 1). Calves can also suffer umbilical hernias, in that the umbilicus fails to close after birth. In dairy heifer calves less than three months of age, Virtala *et al.* (1996) reported that the risk of umbilical hernia was 15.1%. The authors of this study acknowledged that a few of the participating farms were high-risk herds for umbilical hernia and this may have contributed to the elevated incidence of hernia in this study. As a follow-up to this research, Steenholdt and Hernandez (2004) conducted a case-control study to determine risk factors for umbilical hernia in calves less than two months of age. The case and control calves for this study were obtained from a university dairy research herd that had historically had hernia problems among their young calf population. This study demonstrated that there is a hereditary component to umbilical hernias. Calves sired from bulls that had more than two within-herd progeny with herniated navels had a 2.31-fold greater risk of developing a hernia. The risk of umbilical hernia was also 5.65 times greater among calves with an umbilical infection. In addition, a German study of calves at auction houses reported that there is a higher incidence of umbilical hernia in male calves and calves of multiple births (Hermann *et al.,* 2001).

Septicemia is a condition that is commonly observed in calves with diarrhea or umbilical infections, as pathogenic organisms can gain entry to circulation via the damaged intestinal mucosa or the umbilicus. Calves are at highest risk of developing septicemia during the first week of life. Donovan *et al.* (1998) followed a population of dairy calves until six months of age and found that 24% of calves developed septicemia. Among this cohort of calves, septicemia was a significant health problem and the primary cause of calf death. However, anecdotal evidence would suggest that typically less than 5% of young dairy calves develop septicemia.

2.1.5 Conclusion

In conclusion, raising healthy calves can be a considerable challenge for dairy producers. Traditional approaches to the housing, feeding and general management of calves are often met with lack of success. However, improvements in management of calving, colostrum handling and delivery, minimizing environmental exposure to pathogens, enhanced feeding strategies, and provision of appropriate care to sick calves can result in significant improvements in the ability to keep calves healthy.

2.1.6 Literature

Ames, T. R. 1997. Dairy calf pneumonia: the disease and its impact. The Veterinary Clinics of North. America Food Animal Practice, 13: 379-391.

Bowland and Shewen, 2000. Bovine respiratory disease: commercial vaccines currently available in Canada. Can Vet J.41(1): 33–48.

Constable, P.D. 2004. Proceedings of the Dairy Health Management Certificate Program Update Meeting, University of Guelph.

Curtis, C.R., H.N. Erb, and M.E. White. 1988. Descriptive epidemiology of calfhood morbidity and mortality in New York Holstein Herds. Prev. Vet. Med. 5: 293-307.

Donovan, G.A., I.R. Dohoo, D.M. Montgomery, and F.L. Bennett. 1998. Associations between passive immunity and morbidity and mortality in dairy heifers in Florida, USA. Prev. Vet. Med. 34 :31-46

Ellis J., S. Gow, K. West, C. Waldner, C. Rhodes, G. Mutwiri, and H. Rosenberg. 2007. Response of calves to challenge exposure with virulent bovine respiratory syncytial virus following intranasal administration of vaccines formulated for parenteral administration. J Am Vet Med Assoc. 230(2):233-43.

Hermann, R., J. Utz, E. Rosenberger, K. Doll, and O. Distl. 2001. Risk factors for congenital umbilical hernia in German Fleckvieh. Vet. J. 162: 233-240.

NAHMS. 2002. Changes in the United States dairy industry, 1991-2002 USDA:APHIS:VS,CEAH, National Animal Health Monitoring System, Fort Collins, CO #N388.0603.

Osteras, O., M.S. Gjestvang, S. Vatn, and L. Solverod. 2006. Perinatal death in production animals in the Nordic countries – incidence and costs. Nordic Animal Health Mtgs.

Sivula, N. J., T. R. Ames, W. E. Marsh and R. E. Werdin. 1996. Descriptive epidemiology of morbidity and mortality in Minnesota dairy heifer calves. Prev. Vet. Med. 27: 155-171.

Steenholdt, C., and J. Hernandez. 2004. Risk factors for umbilical hernia in Holstein heifers during the first two months after birth. J. Am. Vet. Med. Assoc. 224: 1487-1490.

Svensson, C., K. Lundborg, U. Emanuelson, and S. Olsson. 2003. Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious diseases. Prev. Vet. Med. 58: 179-197.

Trotz-Williams, L.A., B.D. Jarvie, S.W. Martin, K.E. Leslie, and A.S. Peregrine. $2005_{a.}$ Prevalence of Cryptosporidium parvum infection in southwestern Ontario and its association with diarrhea in neonatal dairy calves. Can. Vet. J. 46: 349-351.

Trotz-Williams, L., K.E. Leslie, and A. Peregrine. 2006. Passive immunity in dairy calves and influence of calf management practices. Proceedings of the Ontario Veal Association Healthy Calf Conference.

Trotz-Williams, L.A., S.W. Martin, K.E. Leslie, T. Duffield, D.V. Nydam, and A.S. Peregrine. 2007_{a}. Cryptosporidiosis in Ontario dairy calves I: Calf-level risk factors for infection and diarrhea. Prev. Vet. Med. *In press.*

Trotz-Williams, L.A., S.W. Martin, K.E. Leslie, T. Duffield, D.V. Nydam, and A.S. Peregrine. 2007_{b}. Cryptosporidiosis in Ontario dairy calves II: Herd-level risk factors for shedding of *Cryptosporidium parvum*. Prev. Vet. Med. *In press.*

Virtala, A.K., G.D. Mechor, Y.T. Grohn, and H.N. Erb. 1996. Morbidity from nonrespiratory disease and mortality in dairy heifers during the first three months of life. JAVMA. 208: 2043-2046.

Waltner-Toews, D, S.W. Martin, and A.H. Meek. 1986. Dairy calf management, morbidity and mortality in Ontario Holstein herds. IV. Association of management with mortality. Prev. Vet. Med. 4: 159-171.

Warnick, L.D., H.N. Erb, and M.E. White. 1995. Lack of Association between Calf Morbidity and Subsequent First Lactation Milk Production in 25 New York Holstein Herds. J Dairy Sci. 78:2819-2830.

Wells, S.J., D.A. Dargatz, and S.L. Ott. 1996. Factors associated with mortality to 21 days of life in dairy heifers in the United States. Prev. Vet. Med. 29: 9-19.

2.2 Er det behov for vaksinasjonsprogram for kalv her i landet?

Eiliv Kummen,
Stasjonsveterinær og bestyrer på Geno Øyer testingsstasjon

Geno er avlsorganisasjonen for NRF rasen her i landet. Vi rekrutterer 330 oksekalver hvert år fra besetninger over hele landet. 40 % av kalvene går inn i avlsarbeidet vårt som ungokser. De kommer inn i 3-4 måneders alder til testingsstasjonen. Innkjøringen er puljevis, slik at hele puljen ankommer et eget mottaksisolat i løpet av en uke. Ei inntakspulje består av 20-40 kalver. Når siste kalven har ankommet, starter en 14 dagers karantene. I disse 2 ukene gjennomgår kalvene en rekke faste rutiner og generell observasjon. De tilvendes kraftforautomater og får høy som grovfor. Deretter flyttes dyrene inn i et fjøs med 190 okser fordelt på 12 binger. Bingene har et felles liggeareal i betong som heller 8 % mot ete- og bevegelsesarealet. Dette fungerer som et strøbedd med tråkkutgjødsling. Liggearealet strøs med ca. 2 kg rå sagflis pr. dyr pr. dag. Hver binge er utstyrt med kombinert kraftfor- og veiestasjon. På forbrettet er det alltid tilgang på surfor eller høy.

Fram til januar 2001 var oksene oppstallet på bås. Det var kontinuerlig innkjøring av nye dyr, og rutinene i mottaksfjøset var mer tilfeldig. Kalvene kommer fra hver sin opprinnelsesbesetening. I starten av dyreflyten blandes de tilfeldig sammen. Innen de er 9 måneder er gruppene i binger bestemt for resten av tida på testingsstasjonen. Gjennom innredningen er det kontakt mellom de ulike dyregruppene.

I de fleste besetninger hvor vi til stadighet blander inn nye individer fra ulik bakgrunn, erfarer vi problemer med infeksjonssjukdommer. Dette er også tilfelle på vår testingsstasjon. Mave-/tarminfeksjoner og luftvegsinfeksjoner er de vanligste. Klauvinfeksjoner er også kjent i slike miljøer. Hos oss er det utvilsomt luftvegsinfeksjonene som har forvoldt mest bekymring.
Luftvegssjukdom på kalvene økte dramatisk utover 1990-tallet. De første årene etter årtusenskiftet ble det et så stort problem, at det var en trussel for hele rekrutteringsprogrammet i NRF-avlen. Det var et problem for dyrevelferden og selvsagt også kostnadsmessig. I lange perioder gjennomgikk nesten alle kalvene luftvegsinfeksjon med nedsatt foropptak, feber og påkjent almentilstand. På det meste ble 40% behandlet med antibiotika. Mange av disse fikk varig nedsatt tilvekst. I løpet av et år døde 7 % av langvarig luftvegsinfeksjon.

Noe måtte gjøres.
Vi satte i gang en systematisk gjennomgang av helsesituasjon og driftsforhold. Dyreflyt og inntaksrutiner ble endret som en start på tiltak. Puljevis innslusing med gjennomført ”alt inn/alt ut” prinsipp i mottaksfjøset ble fulgt. Vi fikk gjennomført miljøregistreringer i mottaksfjøs og storfjøs. Fjøsene har balansert ventilasjon med innluft fra kanal over forbrettet og uttak av luft i vifter over tak og i gjødselkjeller. Klimaet i husdyrrommene var ikke tilfredsstillende i de kaldeste vintermånedene og dagene med sterk varme om sommeren. Ventilasjonsanlegget ble gjennomgått til minste detalj. Her var det mye som ikke fungerte som forventet. Den automatiske styringen taklet ikke ”ytterpunktene”. Vi fikk satt inn inntak av luft fra veggene og flere vifter til uttrekk. Etter hvert har vi også innført manuell styring av enkelte funksjoner på ekstra varme eller kalde tider. Hos de minste oksene har vi montert tette plater i veggene rundt liggeareal. Det er tettere oppfølging av strø i bingene, for å være sikre på at de alltid har et tørt liggeunderlag. Etter hvert kom det på plass en bedre styrt opptrapping

av kraftformengde etter alder. Det gir stabile fordøyelsesforhold. Surforet er mye mer stabilt etter at rundballene ble fjernet til fordel for finsnittet gras i plansilo.

Vi halverte antall tilfeller av luftvegsinfeksjon med endringene av driftsforhold, men fortsatt var det for mye sjukdom i fjøset. Vi måtte prøve å finne ut av hvilke sjukdomsframkallende agens som lå til grunn. Symptomene i vårt fjøs stemte bra med det vi kunne lese om som "Bovine respiratory disease" fra mange deler av verden. Det starter med en influensalignende fase med feber opp mot 41grader C, nedsatt appetitt, nedstemthet, rask respirasjon og litt hoste. Denne går ofte over av seg sjøl etter en snau uke. Vektregistreringene våre viser at det er en nedgang i kroppsvekt på flere kilo i denne fasen. Det tar seg raskt opp igjen når kalven kommer i gang igjen. Det tyder på en dehydreringssituasjon. Men altfor mange utvikler noe vi kaller emfysem i lungene. Veggen i lungeblærene brister og mister sin funksjon. Luft kommer ut i vevet omkring og forhindrer nødvendig elastisitet. Vi ser at dyra arbeider med bukmusklene for å få luft inn og ut av lungene. I ødelagt lungevev får bakterier lett tilgang. Da må vi ofte inn med antibiotikabehandling, andre medikamenter og væsketilførsel. De fleste dyra som utvikler emfysem, får varig nedsatt tilvekst. Noen får tilbakefall etter ei tid. Mange av disse dør. Det er et dramatisk symptombilde, og vi bør avlive de før lidelsene blir for store.

En serologisk undersøkelse av oksene over et års tid viste at samtlige hadde antistoffer for corona-virus og BRSV-virus. Noen hadde antistoffer allerede ved ankomst, mens de fleste konverterte under oppholdet på testingsstasjonen. Det ble sendt inn mye materiale for dyrking av bakterier, men resultatene var vanskelige å tolke. Et vanlig svar var "generell blandingsflora". Med tanke på god respons på antibiotikabehandling og mer spesifikke svar i utenlandske undersøkelser tydet det på sviktende metodikk under prøvetaking, forsendelse eller dyrking. Men de vanligst omtalte patogene bakteriene i forbindelse med luftvegsinfeksjon hos storfe har vært isolert hos oss, deriblant Pasteurella haemolytica og Pasteurella multocida.

Alle døde dyr har blitt obdusert opp gjennom årene. Sjukdomsforandringene i lungene er veldig omfattende. De nedre delene av lungene er erstattet med fast, kjøttpreget vev. Nesten alt lungevev er infiltrert av betennelsesceller av kronisk og akutt karakter. De områdene som har igjen luftrom, viser emfysematøse forandringer. I luftrør og bronkier er det mye slim og skum. De omfattende ødeleggelsene av lungevev understreker behovet for å avlive dem før åndenøden kommer for langt.

I 2001 og 2002 var det ingen registrerte vaksiner mot luftvegsinfeksjon på storfe her i landet. Det var liten vilje til å innvilge registreringsfritak for vaksiner som var registrert ellers i EØS-området. Dette endret seg med harmoniseringen av regelverket for legemidler i EØS-landene. Geno bestemte seg for å ta i bruk ei vaksine fra Intervet som heter Bovipast Bovilis. Denne inneholder antigener fra BRSV, et influensavirus og noen stammer av Pasteurella haemolytica. Vi gir kalvene en injeksjon rett etter ankomst. Den gjentas etter en måned. Det er noe sent ifølge vaksineprodusenten, men det er den beste løsningen vi kan få til i vårt system.

I de påfølgende 4 årene falt antall behandlede dyr for luftvegssjukdom ned til under 5 prosent av antall innkjøpte dyr. Vi har mistet 1-2 okser i året som følge av lungelidelser. Det tilsvarer under 1%. Antibiotikabruken ble redusert med mange liter. Det aller viktigste er at oksene har det mye bedre. Gjennomsnitlig tilvekst har gått opp med vel 100 gr lev.vekt pr dag. I den behandla gruppa dreier tilvekstøkningen seg om nærmere 350 gr lev.vekt pr dag.

Erfaringene fra vår drift av testingsstasjon i Geno gjør oss overbevist om at det var rett å gå i gang med vaksinasjon når alle andre faktorer var forsøkt rettet opp. Vi hadde et driftsmessig problem, og vi hadde et omfattende problem for dyrevelferden. All innsats for å få kartlagt årsaksfaktorer viste at det var umulig å bli 100% sikker på at valgte vaksine var riktig, men i blant må en bare forsøke.

Det har vært gledelig å se virkningen av det forebyggende arbeidet vårt i disse årene, men biologien er aldri statisk. Det dukker opp nye ting. Høsten 2005 begynte vi å observere en grov hoste hos enkelte okser. Det var en tydelig bronkitt. For noen av oksene falt tilveksten uten at vi kunne registrere noe på foropptaket. Disse ble behandla med antibiotika med god og varig virkning. Dette har vi hatt enkelte tilfeller av videre framover. Sist vinter fikk vi i januar og februar et skikkelig angrep av denne karakteren. Ca. 40 okser måtte behandles. Siden har det gått bra, men vi må nok forvente nye variasjoner.

Besetningsstørrelsen for storfe stiger i Norge. Kalvestellet i mjølkebesetningene varierer i kvalitet. Livdyrhandelen vil trolig også øke i årene framover. Dette er faktorer som påvirker dyrehelsa til oksene som vi overtar. Miljømessig og diagnostisk oppfølging er viktig for å ha en kontinuerlig overvåking av situasjonen.

2.3 Occurrence of Enteric Pathogens in Faecal Samples from Calves.
Preliminary Results

Evert Jor [1], Stine Margrethe Gulliksen[2], Kai-Inge Lie[3] and Johan Åkerstedet[1]
[1]National Veterinary Institute, Oslo, Norway, [2]TINE BA, Oslo, Norway,
[3]Norwegian School of Veterinary Science, Oslo, Norway

2.3.1 Abstract

In this paper, preliminary results of an ongoing joint research project "Calf Health in Norway" are presented (Lie et al., 2005).
Faecal samples (n=519) from calves and young stock with diarrhoeal disease (0-365 days of age) were assayed for rotavirus, coronavirus, *Cryptosporidium* spp. and *Escherichia coli* F5 (K99) by antigen ELISA (enzyme-linked immunosorbent assay).
Routine bacteriology culture and specific *Salmonella* culture were performed on faecal samples from both healthy calves and calves with diarrhoea from "case herds".
Selected faecal samples from healthy and diseased calves were also investigated for the presence of *Giardia intestinalis*, *Eimeria* spp. and *Cryptosporidium* spp. by direct or immunofluorescense microscopy.
The results of this study indicated that rotavirus and *Cryptosporidium* spp. were associated with diarrhoea in young calves in Norway, while *E. coli* F5 (K99) was detected in a small number of calves. Coronavirus was not detected in any of the samples which may be due to the virus not being present at the time of sampling, or possibly low sensitivity of the assay.
Coccidia seemed to be of some importance in calves from about two weeks of age, but the prevalence in sampled animals without diarrhoea was also very high. The same was the case for *Cryptosporidium* spp. and *Giardia intestinalis*.
Salmonella spp. was not detected in any of the samples tested.
The findings indicate that it may be advisable to sample several animals with clinical diarrhoea when investigating a diarrhoea problem in a herd.

2.3.2 Sammendrag

Her presenteres noen resultater fra det brukerstyrte prosjektet "Kalve- og ungdyrhelse i Norge" (Lie et al., 2005).
Diaréprøver (n=519) fra kalver og ungdyr (0-365 dager) ble undersøkt med en antigen-ELISA (enzyme-linked immunosorbent assay) test for rotavirus, coronavirus, *Cryptosporidium* spp. og *E. coli* F5 (K99).
Fra "problembesetninger" ble avføringsprøver fra et utvalg friske dyr, samt diaréprøver fra enkeltdyr undersøkt ved generell bakteriologisk dyrking og ved spesifikk *Salmonella*-dyrking.
Et utvalg friske og syke kalver ble også undersøkt ved direkte eller immunfluorescens-mikroskopi for forekomst av *Giardia* spp., *Eimeria* spp. og *Cryptosporidium* spp..
Resultatene viste at rotavirus og kryptosporidier var assosiert med diaré hos unge kalver i Norge, mens vi i liten grad har påvist enterotoksiske *E. coli* F5 (K99) i prøver fra dyr med diaré. Coronavirus ble ikke påvist i noen av prøvene, noe som kan skyldes at agens ikke var til stede på tidspunktet for prøvetaking, eventuelt lav følsomhet ved metoden. Koksidier har sannsynligvis også en viss betydning hos kalver allerede fra et par ukers alder, men

forekomsten i prøver fra dyr uten diaré er også meget høy (48,9 %). Det samme ser ut til å være tilfellet for kryptosporidier og *Giardia intestinalis.*
Det ble ikke påvist *Salmonella* spp. i noen av de undersøkte prøvene.
Foreløpige resultater fra studien viser at det er hensiktsmessig å undersøke prøver fra flere dyr med klinisk diaré når det opptrer diaréproblemer i en besetning.

2.3.3 Introduction

Bacteria, parasites and viruses may cause diarrhoea in individual calves and may even cause continuous and severe disease problems on a herd level. *Cryptosporidium* spp., rotavirus group A and coronavirus are internationally recognized as some of the most important causal agents in acute diarrhoea in young calves (Bendali et al., 1999; de Verdier et al., 1998).
Enterotoxigenic *Escherichia coli* (ETEC) F5 (K99) infections seem to play a minor role (Angen, Ø., 2006; Reynolds et al., 1986), whilst the importance of other pathogenic *E. coli* seems somewhat unclear (Angen, Ø., 2006).
Eimeria zuernii and *Eimeria bovis* are regarded as the most pathogenic coccidial species and are relevant in calf diarrhoea cases from approximately two weeks of age (Daugschies et al., 2005). The diplomonad *Giardia interstinalis* is often regarded as a minor pathogen in the calf-diarrhoea-complex (Bjørkman et al., 2003; Maddox-Hyttel, 2006).
Salmonella spp. and infection with bovine virus diarrhoea virus (BVDV) are important etiologic agents in calf diarrhoea in many countries (Angen, Ø., 2006; Reynolds et al., 1986). Infection with bovine torovirus and bovine noroviruses are probably also of clinical significance (Hoet et al., 2003; Wise et al., 2004).
Properties of the disease causing organisms and the host animals, environmental factors, passively acquired immunity, colostrum supply and overall herd immunity against the offending pathogens are crucial factors that determine if clinical disease will be a problem.
This paper presents preliminary results of examined faecal samples from calves and young stock. It illustrates the importance of having a systematic approach when investigating diarrhoea on a herd level as well as having knowledge about factors contributing to clinical disease. The study is a part of the joint research project "Calf Health in Norway" (Lie et al., 2005). The main aim of this project is to gain knowledge about the health status of calf and young stock in Norwegian dairy and beef herds including occurrence of selected pathogenic microorganisms.

2.3.4 Material and Methods

Two hundred and sixty-three herds (171 dairy herds and 92 beef herds), divided in both case herds and control herds consisting of at least 15 animals (i.e. randomly selected herds from The Norwegian Dairy Herd Recording System and The Norwegian Beef Herd Recording System) were included in the study. Faecal samples were collected by field veterinarians from June 2004 to December 2006. The veterinarians and laboratory staff divided the samples by visual inspection in two groups; samples from clinically healthy calves and samples from calves with diarrhoea.
The samples from calves with diarrhoea (Table 1) were assayed for rotavirus group A, coronavirus, *Cryptosporidium* spp. and *E. coli* F5 (K99) by antigen ELISA (enzyme-linked immunosorbent assay) (BIO K 071 from BIO-X Diagnostics, Jemelle, Belgium).
A selection of samples from case herds (calves with and without diarrhoea) was subjected to routine bacteriology culture as well as a specific *Salmonella* selective enrichment and culture method.

The samples were pooled herd-wise for the *Salmonella* culture, while samples from clinical diarrhoea cases were cultured individually. A selection of samples (Table 2) from healthy and diseased calves were also assayed by direct or immunofluorescence microscopy for *Giardia intestinalis*, *Eimeria* spp. and *Cryptosporidium* spp.

2.3.5 Results

Of the 5 989 samples, 519 (8.7 %) were classified as diarrhoeal samples. Of these, 82 (15.8 %) were positive by antigen ELISA for rotavirus, 39 (7.5 %) were positive for *Cryptosporidium* spp., and 16 (3.1 %) were positive for *E. coli* F5 (K99). Coronavirus was not detected in any samples. Of the 137 samples where neither rotavirus, *Cryptosporidium* spp. nor *E. coli* F5 (K99) was detected, 109 (79.6 %) were from calves younger than 30 days of age. A plausible etiologic agent was detected in 26.4 % of samples assayed by antigen ELISA.
Salmonella spp. was not detected in any of 925 samples (68 pooled herd samples and 147 individual diarrhoeal samples) from 48 case herds.
Coccidia (*Eimeria* spp.) were detected in 860 of 1 759 (48.9 %) faecal samples from healthy calves and in 86 of 178 (48.3 %) diarrhoeal samples that were investigated. *Cryptosporidium* spp. were detected in 496 of 1 788 (27.7 %) faecal samples from healthy calves and in 55 of 178 (30.9 %) samples from calves with diarrhoea. *Giardia intestinalis* was detected in 1 017 of 1 788 (56.9 %) faecal samples from healthy calves and in 102 of 176 (58.0 %) samples from calves with diarrhoea.

Table 1 Number (96) of antingen positive faecal samples relative to tal number of samples analyzed by ELISA

Organism	**Calves with diarrhoea (%)**	
	82/519 (15.8)	
Cryptosporidium spp.	39/519 (7.5)	
E. coli F5 (K99)	16/519 (3.1)	
Coronavirus	0/519 (0)	

Table 2 Number (96) of positive faecal from healthy and diarrhoeal calves subject to parasitological investigation by direct or immunofluorescense microscopy

Organism	**Calves with diarrhoea (%)**	**Calves without diarrhoea (%)**
Cryptosporidium spp.	55/178 (30.9)	496/1 788 (27.7)
Eimeria spp.	86/178 (48.3)	860/1 759 (48.9)
Giardia intestinalis	102/176 (58.0)	1 017/1 788 (56.9)

2.3.6 Discussion and conclusion

The preliminary findings of this study are mainly in accordance with studies performed in Sweden and in the United Kingdom (Angen, Ø., 2006; Bjorkman et al., 2003; Reynolds et al., 1986), as well as with a previous survey done in Norway (Valheim et al., 2002) .

The present investigation confirms that rotavirus and *Cryptosporidium* spp. are common diarrhoea-associated pathogens in Norwegian calves, while enterotoxigenic *E. coli* F5 (K99) only was detected in small a number of animals with diarrhoea. Other pathogenic bacteria, like various enterotoxigenic *E. coli* (ETEC), as well as other enteric viruses may also contribute to the diarrhoea-complex in calves and young stock in Norway. This is yet to be investigated.

Coronavirus was not detected in any of the samples from calves with diarrhoea which may be due to the virus not being present at the time of sampling, or possible low sensitivity of the assay.

Coccidia are of some importance in calves from approximately two weeks of age (data from post-mortem examinations in project herds) but the prevalence in samples from animals without diarrhoea is also very high (48.9 %). This seems to be the case for *Cryptosporidium* spp. and *Giardia intestinalis* as well.
In contrast to most other countries, *Salmonella* spp. are rarely detected in samples from calves with diarrhoea in Norway and Sweden. From Denmark and the UK prevalences of 4.2-14.6 % and 12 % have been reported, respectively (Angen, Ø., 2006; Reynolds, D. J. et al., 1986). Infection with bovine virus diarrhoea virus is also relevant in most countries while Norway was declared free of BVDV in November 2006.
In the majority (73.6 %) of diarrhoeal samples no probable etiologic agent was detected by antigen ELISA, suggesting other aetiological agents not included in the assay, dietetic or environmental factors. Some samples may also have been misclassified leading to an underestimate of the true prevalence of the pathogens in calves with disease.
The current findings of this investigation indicate that it may be appropriate to sample several animals with clinical diarrhoea in a herd when investigating a herd problem. The application of quantitative or semi-quantitative methods to detect probable disease causing organisms may aid the clinician when interpreting the test results.

2.3.7 Literature

Angen, Ø. 2006. Diarrhoea in Calves caused by *E. coli* and *Salmonella*. The Swedish Animal Health Service Conference 2006, Halmstad, Sweden.

Bendali, F. et al. 1999. Pattern of diarrhoea in newborn beef calves in south-west France. Vet.Res. 30.1: 61-74.

Bjørkman, C. et al. 2003. *Cryptosporidium parvum* and *Giardia intestinalis* in calf diarrhoea in Sweden. Acta Vet.Scand. 44.3-4: 145-52.

Daugschies, A. and Najdrowski, M. 2005. Eimeriosis in cattle: current understanding. J.Vet.Med.B Infect.Dis.Vet.Public Health 52.10: 417-27.

de Verdier, Klingenberg K. and L. Svensson. 1998. Group A rotavirus as a cause of neonatal calf enteritis in Sweden. Acta Vet.Scand. 39.2: 195-99.

Hoet, A. E. et al. 2003. Association of enteric shedding of bovine torovirus (Breda virus) and other enteropathogens with diarrhoea in veal calves. Am.J.Vet.Res. 64.4: 485-90.

Lie, K, Gulliksen, S, Jor, E., Nafstad, O., Sviland, S., Løken, T., Simensen, E., and Østerås, O. 2005. Calf Health in Norway. Husdyrforsøksmøtet 2005, Lillestrøm.

Maddox-Hyttel, C. 2006. Protozoan parasites of young calves. The Swedish Animal Health Service Conference 2006, Halmstad, Sweden.

Reynolds, D. J. et al. 1986. Microbiology of calf diarrhoea in southern Britain Vet.Rec. 119.2: 34-39.

Valheim, M. et al. 2002. Sjukdomsfremkallende agens ved diaré hos kalv. Husdyrforsøksmøtet 2002, Lillestrøm.

Wise, A. G. et al. 2004. Molecular characterization of noroviruses detected in diarrheic stools of Michigan and Wisconsin dairy calves: circulation of two distinct subgroups. Virus Res. 100.2: 165-77.

2.4 Seroprevalence of Selected Respiratory Infectious Agents in Norwegian Calves and Youngstock.

Kai-Inge Lie [1, 2]***, Stine Margrethe Gulliksen*** [2]***, Evert Jor*** [3] ***and Olav Østerås*** [2]

[1] ***Norwegian School of Veterinary Science, Oslo, Norway ,***

[2] ***TINE BA, Oslo, Norway,***

[3] ***National Veterinary Institute, Oslo, Norway***

2.4.1 Abstract

In this paper, preliminary results of the ongoing research project "Calf Health in Norway" are presented. Serum from randomly selected calves in randomly selected herds were examined with respect to antibodies against *Bovine Respiratory Syncytial Virus* (BRSV), *Parainfluenza virus 3* (PIV-3), *Bovine corona virus* (BCoV) and *Mycoplasma bovis*. In addition the occurrence of respiratory disease in the projects dairy herds was recorded using the Norwegian Dairy Herd Recording System (NDHRS). The results showed that 22.5%, 43.3% and 23.2% of the calves were serologically positive for BRSV, PIV-3 and BCoV respectively. Of the farms included, 52.2%, 79.0% and 57.0% had at least one animal that were seropositive for these agents. All animals tested with respect to *Mycoplasma bovis* were negative. The most frequent diseases reported in calves in the participating dairy herds were enteritis and respiratory disease which made up about ¾ of all diseases reported.

2.4.2 Sammendrag

I det følgende presenteres foreløpige resultater fra det pågående forskningsprosjektet "Kalve- og ungdyrhelse i Norge". Serum fra tilfeldig utplukkede kalver i tilfeldig utplukkede besetninger ble undersøkt med tanke på antistoffer mot *Bovint Respiratorisk Syncytial Virus* (BRSV), *Parainfluensa virus 3* (PIV-3), *Bovint corona virus* (BCoV) og *Mycoplasma bovis*. I tillegg ble det innsamlet data vedrørende forekomst av klinisk luftveissjukdom gjennom den norske helsekortordningen (Kukontrollen). Resutatene viste at 22,5%, 43,3% og 23,2% av kalvene var seropositive for henholdsvis BRSV, PIV-3 og BCoV. Av de inkluderte besetningene hadde 52,2% 79,0% and 57,0% ett eller flere dyr som var positive for disse virusene. Alle dyrene som ble testet med tanke på *Mycoplasma bovis* var negative. Helsekortdata fra deltakerbesetningene viste at mage-/tarmbetennelse og luftveissjukdommer var de vanligste problemene da disse utgjorde nærmere ¾ av all registrert sjukdom.

2.4.3 Introduction

Besides diarrhoea, respiratory disease is found to be the most common and economically important disease in calves (Autio et al., 2007; Olsson et al.,1993, Svensson et al., 2003; Svensson et al., 2006). The nature of the disease is often multifactorial, caused by an unfortunate combination of infectious micro organisms, environment and stress (Roy, 1990). *Bovine Respiratory Syncytial Virus* (BRSV), *Parainfluenza virus 3* (PIV-3), *Bovine corona*

virus (BCoV), *Bovine viral diarrhoea virus* (BVDV) and *Bovine herpes virus 1*, are found to be the most important viral agents involved in respiratory disease complexes in calves and young stock (Autio et al, 2007). An increasing prevalence of *Mycoplasma bovis* is reported in several countries (Byrne et al., 2001).

EFTA Surveillance Authority (ESA) has recognised Norway as free from Infectious Bovine Rhinotraceitis (IBR) since 1994, and Norway was declared free of Bovine viral diarrhoea virus (BVDV) in 2005, with only one positive herd left after going through a national eradication program (Annual report, The National Veterinary Institute, 2005) . In spite of this, according to the Norwegian Dairy Herd Recording System (NDHRS), respiratory disease was the most frequently reported disease event in dairy calves, both bulls and heifers, in 2006. Cattle production in Norway has gone through many changes the last 10-20 years, and is at present changing rapidly. The herds are getting larger, the number of cooperatives is increasing, and the authorities demand all cattle being housed in free stalls by 2024. These changes will probably increase the risk of disease and mortality in calves and young stock in Norway. The aims of the present study were to estimate the prevalence of selected respiratory agents in Norwegian dairy and beef herds.

2.4.4 Materials and methods

During 2004 through 2006 a survey on calf health in Norway was performed (Lie et al., 2005). The study included 261 randomized herds, where of 170 were dairy operations and 91 beef herds, all having at least 15 cow years. The herds were randomly selected from the NDHRS, and the Norwegian Beef Herd Recording System (NBHRS). Each herd participated for one year (365 days), and was visited twice by a project veterinarian during their project period. On each visit, the veterinarian sampled approximately 10 ml of blood from the jugular vein from 12 randomly selected calves under the age of 12 months. Serum from calves older than 150 days were included from the survey. The blood samples were analyzed for the presence of antibodies to Mycoplasma bovis, BRSV, PIV-3 and BCoV at the Norwegian National Veterinary Institute. In farms from which 5 or more calves had been tested, a herd level diagnosis was made. If one or more seropositive animal was found within the herd was classified as positive.

In dairy herds diseases and treatments on calves up to 180 days of age were recorded and reported using the Norwegian Cattle Health Recording System (NCHRS). To secure accurate reporting, the participating herds received 12 health forms, one for each month, which they were to submit to the project independent of whether it had been something to register or not. In cases of disease were veterinarians were not called upon, the farmers were told to record the events themselves based on definitions given by the project. Respiratory disease was defined as coughing or sneezing for 2 days or more or heavy breathing together with additional signs such as nasal discharge. All registrations were reported continually to a central data base managed by TINE Norwegian Dairies. The reporting was done either by the herd's own adviser, by the farmer him-/herself, or by a project employee. A periodically health report was mailed to each farm containing information on the health status in each particular herd.

2.4.5 Results

A total of 8212 dairy calves were born in the herds during the project period. All together 2537 events were reported to the NDHRS, of these 808 (31.8 %) were disease treatments and 1729 (68.2 %) were events of preventive therapy. The most frequent diseases reported in calves in the participating dairy herds were enteritis and respiratory disease which made up about ¾ of all diseases reported. Of the 808 treatments, 301 (37.3 %) were respiratory disease. 25% of all reported cases of respiratory disease occurred before 24 days of age, and 25% occurred after 95 days with a mean age of 53 days.

In the randomly selected herds (both dairy and suckling herds), 354 (22.5%) of 1575 tested calves, had antibodies to BRSV. 57 (52.2%) herds had one or more animal with antibodies to BRSV. 682 (43.3%) of 1964 tested calves had antibodies to PIV-3. 147 (79.0 %) herds had one or more animal with antibodies to PIV-3. 365 (23.2%) of 1576 tested calves had antibodies to BCoV. 106 (57.0 %) herds had one or more animal with antibodies to BCoV. Of 1318 animals tested with respect to *M. bovis* all animals were negative.

2.4.6 Discussion and conclusion

The present study shows that important respiratory pathogens are commonly found in Norwegian cattle.

Our serological results are in agreement with recent results from Sweden. Hägglund et al. (2005) showed that 30%, 48% and 34% of the calves were serologically positive for BRSV, PIV-3 and BCoV respectively.

According to our results *M. bovis* is rare or absent from the Norwegian cattle population. Pneumonia in calves or mastitis in cows caused by *M. bovis* has to our knowledge not been reported in Norway, and our findings are in agreement with this. A recent study has shown that *M. bovis* was not detected in 38 Finnish calf-rearing farms (Autio et al., 2007. These observations are in contrast to the situation reported from other parts of the world, where *M. bovis* is considered one of the most important causes of respiratory disease (Byrne et al., 2001).

A significant difference in herd level prevalence of the two respiratory pathogens BRSV and PIV-3, almost four-fold, was observed. This may indicate important epidemiological differences between these two viruses, and hence may show a potential for preventing respiratory disease caused by BRSV.

2.4.7 Literature

Autio, T., Pohjanvirta, T., Holopainen, R., Rikula, U., Pentikainen, J., Huovilainen, A., Rusanen, H., Soveri, T., Sihvonen, L., Pelkonen, S. 2007 Etiology of respiratory disease in non-vaccinated, non-medicated calves in rearing herds. Vet.Microbiol. 119:256-265

Byrne, W.J., McCormack, R., Brice, N., Egan, J., Markey, B., Ball, H.J. 2001. Isolation of Mycoplasma bovis from bovine clinical samples in the Republic of Ireland. Vet.Rec. 148:331-333

Hagglund, S., Hjort, M., Graham, D.A., Ohagen, P., Tornquist, M., Alenius, S. 2007. A six-year study on respiratory viral infections in a bull testing facility. Vet.J. 173:585-593

Lie, K., Gulliksen, S., Jor, E., Nafstad, O., Sviland, S., Løken, T., Simensen, E., and Østerås, O. Kalve- og ungdyrhelse i Norge. 2005. Husdyrforsøksmøtet 2005.

Olsson, S.O., Viring, S., Emanuelsson, U., Jacobsson, S.O. 1993. Calf diseases and mortality in Swedish dairy herds. Acta.Vet.Scand. 34:263-269

Roy, J.H.B. 1990. Respiratory infections. In: Roy JHB: The Calf, management of health. Butterworths, London. 132-53.

Svensson, C., Hultgren, J., Oltenacu, P.A. 2006. Morbidity in 3-7-month-old dairy calves in south-western Sweden, and risk factors for diarrhoea and respiratory disease . Prev.Vet.Med 74:162-179

Svensson, C., Lundborg, K., Emanuelson, U., Olsson, S.O. 2003. Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious diseases. Prev.Vet.Med. 58:179-197

2.5 Protocol for the Recording of Calf Health in Norwegian Dairy Herds

Nina Fjerdingby, Egil Simensen
Norwegian School of Veterinary Science, Oslo, Norway

2.5.1 Abstract

This presentation deals with the different steps of a protocol for recording calf health in dairy herds. The protocol consists of the following components: Collecting herd records, defining objectives, farm inspection, decision making, recommendations for changes and follow-up. Herd data including disease treatments are collected from the Norwegian Cattle Health Services, laboratory results and information from the farmer. Priorities are discussed and related to the goals of the farmer. The farm visit consists of recording risk factors contributing to the occurrence of calf diseases; that is housing (hygiene, bedding), barn climate (temperature, humidity, ventilation, gases), feeding management, clinical inspection, on-farm disease and biosecurity and eventual supplementary collection of materials for laboratory analyses. All findings are discussed with the farmer and an advisory plan for the shorter and the longer term designed. This will be reflected in a short, written farm visit report, no longer than one sheet. At the follow-up visit the effects of recommended interventions should be evaluated. Examples of current protocols will be presented.

2.5.2 Sammendrag

En protokoll som beskriver prosedyre for systematisk gjennomgang i besetninger ved utredning og rådgivning om kalvehelse omtales. Prosedyrebeskrivelsen inneholder følgende trinn i en besetningsutredning: Kartlegging, prioritering av rådgivningsområde, registreringer i besetningen og på dyra, oppsummering, tiltaksplan og evaluering/oppfølging. Ved kartlegging av situasjonen nyttes helse- og produksjonsdata fra Tine rådgivnings utskrifter og Tine helseweb, laboratoriedata og opplysninger fra eier. Rådgivningsområde prioriteres ut fra hvilke aldersgrupper og typer problemer som kan ha behov for forbedringer og ekstra oppfølging. Risikofaktorer for ulike sykdommer registreres og vurderes i forhold til eierens målsetting, anbefalte mål og verdier eller krav i forskrifter og anbefalinger i retningslinjer for hold av storfe. Følgende sjekkpunkter er med i protokollen: Oppstalling, klima, renhold og hygiene, smittevern, fôring, klinisk undersøkelse, tilvekstmåling og eventuell supplerende prøvetaking for laboratorieanalyser. Det er utarbeidet et eget tiltaksskjema for notering av de tiltak som rådgiver og eier er enige om. Protokollen inkluderer også evaluering og oppfølging av foreslåtte tiltak. Eksempler på aktuelle protokoller vil bli gitt.

2.5.3 Introduction

Calves performance and health should be monitored throughout the rearing period in order to obtain optimal development. Important factors to focus on are record keeping, optimal housing, disease prevention, disease detection, and early and proper treatment of diseased young stock, and adequate nutrition. This protocol is a scheme of the most important steps during a herd evaluation of calf health to give the best background for decision making and

recommendations for possible changes. The protocol is developed to be a tool for tuition of veterinary students of herd health and production management at the Norwegian School of Veterinary Science. It works as a template to monitor calf health in real herds and in paper cases, and it may be a starting-point for further tuition of clinical signs, risk factors, diagnostic tests, treatment and prophylaxis of current diseases in calves. The aim of this presentation is to introduce the protocol to practitioners of herd health and production management and to focus on its practical importance in recording risk factors and improving calf health in dairy herds.

2.5.4 Materials and methods

Tools

1. Farm data concerning health (mortality and disease treatments) of calves in The Cow Health Card System and The Cattle Health Services.
2. Nutrient requirement standards tables and forage analysis data
3. Scales for weighing the calves or a measuring tape for growth measurements (chest girth)
4. Material for collecting nasal secretions, blood, urine and feacal samples for laboratory diagnostic examinations.
5. Relevant instrumentation for monitoring immunoglobulin content of colostrum and calf serum.
6. Tools for recording farm conditions: floor, cubicles, hygiene, bedding, ventilation and climate.
7. Farm check list: procedures for pen cleaning and milk feeding hygiene, vaccination schedules, internal and external parasite control programs, isolation of purchased calves/animals.

Methods

A health and production management protocol for dairy calves consists of the following components:

- Data inspection and calculation of relevant indices
  - The Cattle Health Services data
  - The Cow Health Card System data
  - Laboratory data
  - Farmer's informtion
- Defining objectives
  - Age of calves with problems
  - Priorities related to farmer's goals
- Farm inspection
  - Clinical examination of the calves
  - Growth measurements
  - Housing: Floor, cubicles, hygiene, bedding
  - Feeding procedures, ration evaluation and feeding hygiene
  - Climate
  - General hygiene and biosecurity
  - Sampling for diagnostic tests (post-mortem, faeces, blood)
- Decision making
  - Evaluation and interpretation of information
  - Comparison of actual performance indices and risk factors with farmer's targets
- Recommendations for changes

Advisory plan designed for the shorter and the longer time

- Follow-up visits
  - Assessing recommended interventions
  - Evaluate health and performance in relation to farmer's targets
  - Procedures for follow-up

Procedure

Assignments	**Where and when to be executed by the practitioner**
Herd data from The Norwegian Cattle Health Services	Inspection and calculation of relevant indices in practitioner's office
Defining objectives/targets	Together with farmer in farmer's office
Clinical examination, growth measurements, housing and climate	Farm inspection in cowshed
Decision making	In farmer's office
Recommendations for changes and advisory plan in a short report	Discussion in farmer's office
Appointment for follow-up visits	In farmer's office before leaving farm
Assessing recommeded interventions	Follow-up visits on farm

Calf health parameters

The Annual Report from the Norwegian Cattle Health Services 2004 reports incidences of calf diseases. However, only 40 % are supposed to be actually reported. In "Helseutskrift" all diagnoses the last 12 months for individual herds are listed, providing that they have been reported. These herd data may give a background for own comparisons.

Mortality rate and optimal growth are the two specific measures of calves' health condition in a herd. According to the Norwegian Dairy Herd Recording for 2005 average mortality rates were as follows: Abortions 0.70 %. stillbirths 2.90 %, deaths of live born calves 0.90 %

Calf growth should be 500 g per day first month, then 700-800 g per day. A survey of calf growth in herd is obtained by measuring chest girth and compare with a 'normal growth rate' Norwegian Red dairy calves that is calculated Y = 74 + 0,27X. Calf's age in days is X. In the diagram the measured value for each calf can be compared with 'normal' values or the difference between measured and 'normal' values may be computed in per cent. Calculating mean deviation for all calves or for different age groups can provide information related to feeding, health and diseases.

2.5.5 The calf health protocol

In the following the protocol used at the Norwegian School of Veterinary Science is presented in Norwegian. An English version can be obtained upon request.

In Norwegian:
I skjemaet står de samme miljøfaktorene listet opp under hver aldersgruppe. I mange tilfeller er det ikke nødvendig å notere alt dette for alle aldersgrupper. Ofte er det en spesiell aldersgruppe som har et problem eller som trenger ekstra oppmerksomhet. Det er naturlig at det brukes mest tid på dem og at det ikke legges opp til full registrering av hvordan alle kalvene har det. I rubrikken 'målsetting' skal det, avhengig av stikkord, stå bondens målsetting, anbefalte mål og verdier eller offentlige krav og retningslinjer. Denne rubrikken bør brukes så mye som mulig i undervisningen for på den måten å konkretisere risikofaktorer.

Plan for utredning av kalvehelse i besetninger			
Dato	**Produksjon**	**Antall årskyr**	**Neste besøk**
Produsent			
Til stede	**Begrunnelse for besøket**		
Beskrive problemet /saken /situasjonen			
Steg 1: Forberedelse	**Registreringer**	**Målsetting og kommentarer**	
Helseutskrift/ Andre dyr med helseopplysninger			
- Sykdomskoder			
- Forebyggende koder (inkl vaks)			
Helseweb			
- Mine dyr/ Dyrestatus/ Enkeltindivid			
- Resultater/ Behandlinger			
- Reultater/ Behandl/ Forebygg.kalver			
Årsutskrift			
Mista kalver			
Kalvingstidspunkt (spredt/kons)			
Innkjøp av dyr/kalver			
Periodeutskrift buskap			
Mista kalver			
Kalvinger siste 3 mnd			
Innkjøp av dyr			
Analysesvar			
Obduksjoner			
Totalprotein			
IgG i råmelk			
Bakteriologi			
Serologi			
Aldersgruppe som trenger ekstra oppmerksomhet			

Steg 2: Første gårdsbesøk			
Del A: Samtale inne			
Bondens målsetning og forventning til utredningen			
Bondens utplukk av dyr og saker som trenger ekstra oppmerksomhet			
Helsedata som ikke kom med i steg 1			
Konklusjon fra steg 1 drøftes			
Del B: Fjøsrunde	**Registreringer**	**Målsetting og kommentarer**	
Fødsel			
Oppstalling og miljø			
- Fødebinge/ bås			
- Antall fødebinger i besetningen			
- Antall årskyr per fødebinge			
- Renhold i fødebinge			
- Hvor lenge er kalven i fødebingen			
- Når settes kalven i enkeltbinge?			
Råmelkstildeling			
- Kun patting			
- Patting og smokk/bøtte			
- Mengde innen 2 timer			
- Mengde det første levedøgnet			
Navlehygiene			
- Pensling (i tilfelle med hva)			
Første leveuke			
Oppstalling og miljø			
- Kalv og mor sammen alene			
- Kalv og mor i fellesbinge			
- Kalv uten mor i enkelt-/ fellesbinge			
- Liggeunderlag			
- Renhold i bingen			
- Gasser			
- Trekk			
- Temperatur			
Fôring			
- Råmelk: Sur/søt			
- Råmelk: Mengde per dag			
- Tørrfôr (grovfôr, kraftfôr)			
- Vann			
Klinisk undersøkelse			
- Mage- tarmlidelse			
- Luftveislidelse			
- Navleinfeksjon			

- Leddbetennelse			
- Sepsis			
Antall syke (regn ut andel)			
Fra 1 uke til avvenning			
Oppstalling og miljø			
- Enkeltbinge			
- Fellesbinge			
- Renhold i bingene			
- Liggeunderlag			
- Antall kalver per binge			
- Aldersspredning per binge			
- Alt-inn alt-ut / kontinuerlig			
- Ventilasjon			
- Gasser			
- Trekk			
- Temperatur og fuktighet			
Fôring			
- Melk: Søt, sur, erstatning			
- For surmelk angis metode			
- og pH hvis kjemisk syrnet			
- Mengder melk			
- per mål / per dag			
- fri tilgang			
- Antall melkefôringer per dag			
- Melkefôringsteknikk:			
- Bøtte / Smokk			
- Melk fôres kald /varm (temp)			
- Grovfôr			
- Kraftfôr			
- Vann			
Klinisk undersøkelse			
- Mage- tarmlidelse			
- Luftveislidelse			
- Navleinfeksjon			
- Leddbetennelse			
- Sepsis			
Antall syke (regn ut andel)			
Avvenningsalder			
Fra avvenning til 6 mnd			
Oppstalling og miljø			
- Renhold i bingene			
- Liggeunderlag			
- Antall kalver per binge			
- Aldersspredning per binge			
- Alt-inn alt-ut / kontinuerlig			
- Ventilasjon/ luftskiftebehov			
- Gasser			
- Trekk			
- Temperatur og fuktighet			
Fôring			

- Typer tørrfôr			
- Typer kraftfôr og mengde			
Klinisk undersøkelse			
- Mage- tarmlidelse			
- Luftveislidelse			
- Navleinfeksjon			
- Leddbetennelse			
Antall syke (regn ut andel)			
Tilvekst (eget skjema)			
Steg 3: Mer info nødvendig			
Analyser			
Registreringer fra gårdbruker			
Registreringer fra veterinær			
Steg 4: Diskusjon / Oppsummering og konklusjon			
Steg 5: Tiltaksplan			
Tiltaksskjema på egen side			
Steg 6: Oppfølgingsbesøk med evaluering			
Ferdig utførte tiltak	**Gjenstående tiltak**	**Nye tiltak**	
Vurdere utviklingen i forhold til målsettingen			
Møteplan			

Tiltaksskjema	
Produsent	
Produsentnummer	
Adresse	Telefon
Rådgiver	
Veterinær	
Første besøk, dato:	Oppfølgingsbesøk, dato:
Nyfødte kalver og første leveuke	
Tiltak på kort sikt	Tiltak på lang sikt
Fødebinge	

Tiltak på kort sikt	Tiltak på lang sikt
Kalver fra 1 uke til avvenning	
Tiltak på kort sikt	Tiltak på lang sikt
Kalver fra avvenning til 6 mnd	
Tiltak på kort sikt	Tiltak på lang sikt
Smitte utenfra	
Tiltak på kort sikt	Tiltak på lang sikt
Andre prioriteringer/anmerkninger	
Tiltak på kort sikt	Tiltak på lang sikt
Sted	Dato
Veterinær Rådgiver	Eier

2.5.6 Literature

Brand, A., Noordhuizen, J.P.T.M., Schukken, Y.H. 1996. Herd Health and Production Management in Dairy Practice. Wageningen Academic Publ, Wageningen, The Netherlands.

Cannas da Silva, J., Noorhuizen, J.P.T.M., Vagneur, M., Bexica, R., Gelfert, C.C., Baumgartner, W. 2006. The Future Of Veterinarians In Bovine Herd Health Management. 24th World Buiatrics Congress.

Radostits, O.M. 2001. Herd Health Food Animal Production Medicine 3rd ed. W.B. Saunders Company, Philadelphia, Pennsylvania, USA.

2.6 The efficacy of meloxicam (Metacam®) as an adjunct therapy in the treatment of neonatal calf diarrhea complex

Cynthia G. Todd[1], Dennis R. McKnight[2], Suzanne T. Millman[1], Todd F. Duffield[1] and Kenneth E. Leslie[1]

[1] Department of Population Medicine, University of Guelph, Guelph, Ontario, Canada, N1G 2W1

[2] Kemptville Campus, University of Guelph, Kemptville, Ontario, Canada, K0G 1J0

2.6.1 Abstract

Diarrhea is a significant health problem among neonatal dairy calves. In some countries, calves with diarrhea may be treated with supportive therapies, such as non-steroidal anti-inflammatory drugs. The aim of this research was to examine the clinical efficacy of meloxicam as an adjunctive therapy for calves with diarrhea, as determined by measures of calf performance, behaviour and health. For this double-blind controlled trial, 62 Holstein bull calves were purchased at birth and transported to a calf research facility. At the naturally occurring onset of diarrhea, the calves were enrolled in the study, and randomly assigned to receive a single subcutaneous injection of meloxicam (0.5 mg/kg BW) or an equal volume of placebo. Individual calf starter ration, water and milk intakes were determined daily for all calves until 56 days of age. Daily fecal consistency scores and weekly body weight measurements were also collected for each study calf. Following the onset of diarrhea, calf feeding behaviour and general activity, as well as lying and standing postures were observed for six consecutive days. During this trial, 56 calves developed diarrhea and were treated with meloxicam (n=28) or placebo (n=28). Meloxicam-treated calves began consuming starter ration significantly earlier ($p<0.05$), had improved starter intakes ($p<0.05$) and experienced greater body weight gain over the study period ($p<0.05$), as compared to placebo calves. In addition, meloxicam calves tended to wean at an earlier age than placebo-treated animals ($p=0.11$), but were not different for weaning weight ($p>0.05$). After developing diarrhea, meloxicam calves were more likely to consume their milk meals ($p<0.05$) and required less assistance during milk feedings ($p<0.05$) than placebo-treated animals. Meloxicam calves were also more sedentary for the first two days after developing diarrhea, and then became considerably more active ($p<0.05$). The study calves did not differ for the occurrence of abnormal lying postures ($p>0.05$) or back arch ($p>0.05$). However, meloxicam calves were more frequently observed with a natural tail position ($p<0.05$). These results suggest that meloxicam may be an appropriate supportive therapy for calves with diarrhea.

2.6.2 Sammendrag

Diarè er et svært viktig helseproblem hos unge kalver. I noen land er det vanlig å gi kalv med diarè tilleggsbehandling med for eksempel NSAID (non-steroide anti-inflammatorsike midler). Formålet med dette forskningsprosjektet var å undersøke den kliniske effekten av meloxicam som tilleggsbehandling for kalv med diarè. Vi undersøkte effekten på kalvenes eting, tilvekst, atferd og helse. Det ble brukt forsøksoppsett med dobbelkontroll. I alt 62 Holstein oksekalver ble kjøpt ved fødsel og transportert til forskningsfjøset. Ved naturlig utvikling av diarè ble kalvene inkludert i forsøket og tilfeldig fordelt mellom å få subcutan injeksjon, en dose meloxicam (0,5mg/kg lev. vekt) eller tilsvarende volume av placebo.

Individuelt opptak av kalvekraftfôr, vann og melk ble registrert daglig til kalvene var 56 dager. Konsistens av avføring ble registret daglig og alle kalvene ble veid ukentlig. Etter hvert som kalvene fikk diarè observert vi i de6 påfølgende dagene generell atferd, eteatferd og dyrenes kroppsstilling når de stod eller lå. I løpet av forsøket utviklet 56 kalver diarè, 28 kalver ble behandlet med meloxicam og 28 kalver med placebo. Kalver behandlet med meloxicam begyndte å ete kraftfôr raskere ($p<0,05$), hadde høyere kraftfôropptak ($p<0,05$) og høyer tilvekst ($p<0,05$) enn placebobehandlet kalver. Det var også en tendens til at meloxicambehandlet kalver ble avvent tidligere ($p=0,11$), men de hadde ikke forskjellig avvenningsvekt i forhold til placebobehandlet kalver. Etter at kalvene hadde utviklet diarè var det større sannsynlighet for at kalver behandlet med meloxicam drakk rasjonen med melk ($p<0,05$) og de trengte mindre hjelp i forbindelse med melkefôring ($p<0,05$) enn placebobehandlet kalver. Kalver behandlet med meloxicam var mer inaktive de to første dagene etter de utviklet diarè, men de ble deretter langt mer aktive enn placebokalvene ($p<0,05$). Kalvene i begge gruppene hadde lik forekomst av unormal liggestilling og krum-rygg når de stod ($p>0,05$). Likevel ble kalver behandlet med meloxicam oftere observert med normal halestilling ($p<0,05$). Resultatene tyder på at meloxicam gir god tilleggsbehandling for kalv med diare.

2.6.3 Introduction

Neonatal calf diarrhea complex is a leading cause of morbidity and mortality among preweaned dairy calves. The observational calf health literature reports that the incidence risk for calfhood diarrhea ranges between 10% and 35% (Waltner-Toews *et al*., 1986; Donovan *et al*., 1998; Svensson *et al*., 2003). Furthermore, the National Animal Health Monitoring System estimates that calf diarrhea accounts for greater than 60% of preweaned calf deaths (USDA, 2002). Thus, it is evident that neonatal calf diarrhea complex has a significant impact on the dairy industry and as such, there is considerable need for research into prevention and supportive therapies for this disease.

Meloxicam (Metacam®) is a non-steroidal anti-inflammatory drug (NSAID) of the oxicam class that has anti-inflammatory, anti-exudative, analgesic and antipyretic properties. This NSAID acts by preferentially inhibiting cyclooxygenase-2, an enzyme that catalyzes the synthesis of inflammatory mediators, such as prostaglandins and thromboxanes. The half-life of meloxicam in young cattle is 26 hours. Therefore, given its cyclooxygenase-2 selectivity and long half-life, meloxicam could have a role in mitigating sickness behaviour and promoting recovery in calves with diarrhea.

A recent field study in Europe examined the efficacy of meloxicam administration in combination with oral rehydration and antibiotic therapy to calves with neonatal calf diarrhea complex (Philipp *et al*., 2001). This European study reported that meloxicam-treated calves experienced significant improvements in clinical parameters, such as hydration status, fecal consistency, rectal temperature and signs of visceral pain, as well as reduced need for re-treatment with antibiotic or oral electrolytes, as compared to calves treated with placebo. As a follow-up to this European research, the objective of the present study is to examine the clinical efficacy of meloxicam as adjunctive therapy for calves with neonatal calf diarrhea complex, as determined by measures of calf performance, health and behaviour.

2.6.4 Materials and Methods

For this research study, Holstein bull calves were purchased at birth from three commercial dairy farms in eastern Ontario, Canada. All calves received colostrum and were uniquely identified with NLID tags at the farm of birth. The experimental calves were transported to the Calf Research Facility, Kemptville Campus, University of Guelph, Kemptville, Ontario, Canada at one to two days of age. The experimental calves were housed in individual polyethylene hutches for the duration of the trial. An initial body weight measurement was determined for each calf upon arrival at the calf research facility. In addition, blood samples were collected by venepuncture from the study calves on the day of arrival. Serum was harvested and analyzed for serum total solids (TS) concentration, allowing the investigators to determine the uniformity among the study calves for transfer of maternal immunoglobulins.

The management conditions that the experimental calves were exposed to were representative of commercial dairy operations in Ontario. A*d libitum* calf starter ration and water were available to the calves throughout the study period, beginning on the day of arrival. The experimental calves were also provided with 2 L of whole milk twice daily at 8:00 a.m. and 4:30 p.m. from arrival until weaning. The calves were weaned from their milk diet once they were greater than 28 days of age and had consumed a minimum of 750 g/day of calf starter ration for three consecutive days. *Ad libitum* hay was offered to the calves after weaning.

Calf starter ration, water and milk intakes were determined daily for each experimental calf from arrival until 56 days of age. All calves was weighed weekly (7, 14, 21, 28, 35, 42, 49 and 56 days of age) and on the day of weaning. Individual calf fecal consistency scores were assigned daily, using a four-point scale (1 = normal, firm not hard; 2 = soft, does not hold form; 3 = runny, spreads easily; 4 = devoid of solid matter). A fecal score greater than 2 was described as diarrhea. Fresh feces were collected from the rectum of each calf on days 7, 14 and 21 of age, as well as at the onset of diarrhea. The fresh fecal samples were analyzed for *Escherichia coli* K99 (F5), bovine rotavirus, bovine coronavirus and *Cryptosporidium parvum* using the BioX Diagnostics lateral immunochromatography test (Bio-X Diagnostics, Jemelle, Belgium; Trotz-Williams *et al*., 2005).

At the naturally occurring onset of diarrhea, defined as the first occurrence of a fecal score greater than 2, the calves were enrolled in the study. The study calves were randomly assigned to receive a single subcutaneous injection of meloxicam (Metacam® 20 mg/mL solution for injection for cattle, pigs and horses, Boehringer Ingelheim Vetmedica GmbH., Ingelheim, Germany) at a rate of 0.5 mg/kg body weight or an equal volume of placebo solution. All of the meloxicam and placebo treatments were administered to the calves at approximately 9:30 a.m. on the day of enrollment, under the skin of the neck, anterior to the right front shoulder using a 20 gauge needle. The research staff were blinded to treatment assignment. Beginning on the day of enrollment, the experimental calves were also provided with *ad libitum* oral electrolyte solution, and supplementation continued until the consistency of the calf's feces returned to a fecal score of 1 or 2. In addition, any experimental calf with diarrhea or other clinical illness that required additional therapy (ie. intravenous fluids, antibiotics, etc.), were treated as indicated in the standardized on-farm protocol.

After enrollment in the trial, the study calves were subject to an intensive six day observation period (D0 to D5). The feeding behaviour and appetite of the study calves was monitored

during the morning and afternoon feedings. Research technicians observed each individual calf and recorded whether he was resting, standing or active at three different time points (pre-milk delivery, at-milk delivery and post-milk delivery) during feeding. In addition, the proportion of offered milk that was consumed was recorded. Any calf that did not consume his entire morning meal was offered the remainder of the milk at later time during the morning. Calf activity also monitored during the post-enrollment observation period. On D0, each experimental calf was fitted with a digital pedometer that was secured within an elastoplast wrap around the calf's chest. The pedometers quantified the number of steps taken by the calf throughout the day. The number of steps for each calf was recorded daily from D0 to D5. Baseline information was not collected because the pedometer was attached after the calf presented with clinical signs of diarrhea.

Lying and standing postures for the calves were evaluated as indicators of calf discomfort. A visual analogue scale for lying posture was adapted from a published assessment of acute pain in farm animals (Molony and Kent, 1997). All of the research technicians involved in the study were trained to assess lying posture. A single, mid-afternoon direct observation of calf lying posture was completed from D0 to D5. Subsequently, the calves were identified as either lying normally or abnormally. Calf standing posture was captured daily from D0 to D5 using digital photography. Each morning, calves were removed from their hutches, allowed to walk about and then at calf-level, a photograph of each calf in its natural standing position was taken. A formal blind evaluation of the photographs was later completed, in which each photograph was scored for tail position (natural hang, tucked or raised) and back arch (arched or not arched).

Data were entered into Microsoft Office Excel 2003 and then imported into SAS 9.1 (SAS Institute Inc., Cary, North Carolina) for statistical analysis. Initially, summary statistics and frequency tables were generated for continuous and categorical variables, respectively. Crude associations between treatment and each outcome variable were examined using t tests and Pearson's chi square. Subsequently, multivariable models were constructed to describe the impact of meloxicam therapy on meaningful outcome variables. In all analyses the primary experimental unit was the individual calf.

2.6.5 Results and Discussion

In total, 62 calves were purchased at birth and relocated to the calf research facility. Of the purchased calves, 56 presented with clinical signs of diarrhea, and were subsequently enrolled in the trial. One calf died before enrollment in the study. Random assignment resulted in 28 calves receiving meloxicam and 28 calves receiving placebo. Two placebo-treated calves died after enrolling in the trial.

The experimental calves did not differ for arrival body weight by treatment (meloxicam = 46.9 kg and placebo = 46.1 kg, p=0.80). Overall, transfer of passive immunity among the study calves was poor. Mean serum TS concentrations for the meloxicam and placebo-treated calves were not different (4.0 g/dL and 4.1g/dL, respectively, p=0.89). The incidence risk for failure of maternal antibody transfer, based on a serum TS cut-point of less than 5.2 g/dL, was 73.1% and 81.5% for the calves receiving meloxicam and placebo, respectively. The mean age for the onset of diarrhea was 10.5 and 9.2 days for the meloxicam and placebo calves, respectively (p=0.22). All of these relationships provide strong evidence that random assignment of calves to treatment group was successful.

The Kaplan-Meier survival function estimates for time to starter consumption demonstrate that meloxicam-treated calves began consuming starter ration five days earlier than placebo calves (Figure 1). Moreover, after satisfying the starter consumption criteria, meloxicam calves consistently consumed more starter ration than placebo-treated calves (Figure 2). In addition, meloxicam-treated calves consumed significantly more total starter ration over the study period (meloxicam = 39.5 kg and placebo = 27.3 kg, $p<0.05$). These differences in starter consumption between the meloxicam and placebo calves are likely associated with sickness behaviour. During disease states, pro-inflammatory cytokines are released in response to infection and inflammation, causing a loss of appetite and reduced feed intake (Hart, 1988). In this study, the anti-inflammatory activity of meloxicam may have blocked the pro-inflammatory cytokine pathway and in turn, meloxicam calves were more motivated to engage in feeding behaviour.

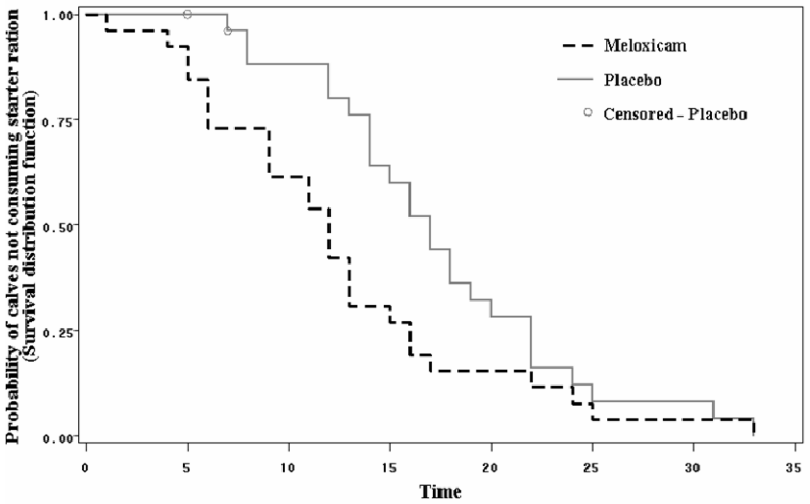
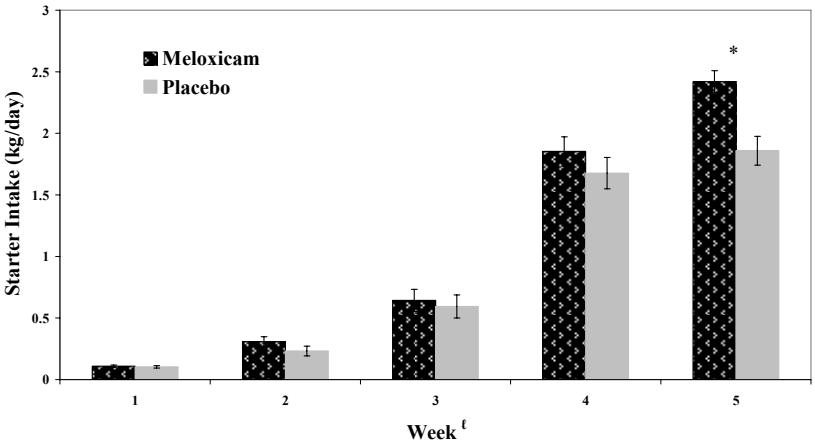


Figure 1: Kaplan-Meier survival function curves for time to starter consumption



* Treatment differences significant at $p<0.05$
ℓ Relative to satisfying the time to starter consumption criteria

Figure 2: Least square means and standard errors for starter ration consumption over the study

Meloxicam-treated calves also experienced greater body weight gain after diarrhea, in that meloxicam and placebo calves gained 4.2 kg and 3.7 kg per week, respectively ($p<0.05$). The

higher body weight gain among the meloxicam calves was likely an effect of improved starter ration intake.

Weaning weights for the meloxicam and placebo-treated calves were not different (p>0.05). Nonetheless, calves receiving meloxicam therapy tended to wean six days earlier than placebo calves (p=0.11; Figure 3). Given that the weaning criterion was based on starter ration intake, the differences in age at weaning can be attributed to the earlier starter consumption for the meloxicam-treated calves.

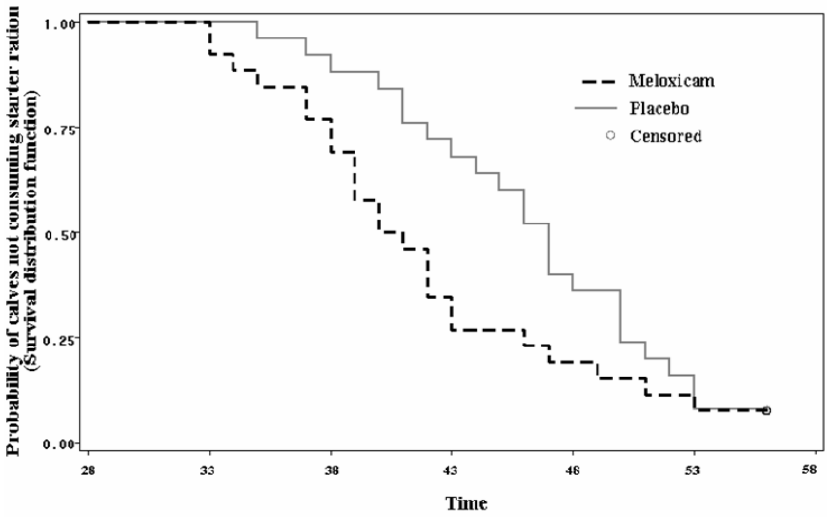


Figure 3: Kaplan-Meier survival function curves for time to weaning

There was no difference in milk consumption among younger calves that were treated with meloxicam or placebo solution. However, calves that developed diarrhea and were treated with meloxicam after 10 days of age, were significantly more likely to consume their entire milk meal, compared to placebo-treated calves (OR=5.30, p<0.05). Furthermore, the odds of meloxicam-treated calves needing assistance during milk feedings was 49% lower than placebo calves (OR=0.51, p<0.05). These results demonstrate that meloxicam-treated calves had improved appetite, and were more motivated to consume milk.

Meloxicam calves tended to be more sedentary for the first two days following the onset of diarrhea, and then became considerably more active during the remainder of the observation period (p<0.05). It is hypothesized that treatment with meloxicam may have alleviated some of the visceral discomfort associated with an episode of diarrhea. Thus, meloxicam-treated calves were more comfortable and able to spend more time resting and recovering from diarrhea.

The study calves did not differ for the occurrence abnormal lying postures (OR=0.99, p>0.05) or back arch (OR=0.71, p>0.05). However, meloxicam-treated calves were more frequently observed with a natural tail position (OR=2.30, p<0.05). These behaviours were examined as indirect indicators of discomfort. It was hypothesized that meloxicam treatment would be strongly correlated with normal lying postures, non-arched backs and natural tail positions. There is a concern that the direct scan sampling used to assess calf lying posture was not completed frequently enough to capture the true effect of meloxicam therapy on lying posture. In addition, the visual analogue scale used to evaluate lying posture has been validated to assess acute pain in lambs after castration, but has not been used to investigate sickness-related pain and discomfort. Thus, the visual analogue scale may need to be refined in order to increase its sensitivity for such evaluations. The use of digital photographs to evaluate calf

standing posture is novel to this area of research. Tail position proved to be a more sensitive measure of calf discomfort than back arch. Increased standardization of the calf photographs would have allowed for other indicators of calf discomfort to be explored.

2.6.6 Conclusion

These results demonstrate that calves with neonatal calf diarrhea complex may benefit from meloxicam treatment. Over the study period, meloxicam-treated calves consumed significantly more calf starter ration and experienced greater body weight gain than placebo calves. Furthermore, after the onset of diarrhea, meloxicam calves showed improved milk consumption, were less likely to need assistance during milk feedings, showed increased activity over time, and were more frequently observed with a natural tail position, as compared to placebo-treated calves. These results provide evidence of improved calf well-being and indicate that meloxicam may be an appropriate supportive therapy for calves with diarrhea.

2.6.7 Literature

Donovan, G.A., I.R. Dohoo, D.M. Montgomery and F.L. Bennett. 1998. Associations between passive immunity and morbidity and mortality in dairy heifers in Florida, USA. Prev. Vet. Med. 34: 31-46.

Hart, B. L. 1998. Biological basis of the behaviour of sick animals. Neurosci. Biobehav. Rev. 12: 123-137.

Molony, V. and J.E. Kent. 1997. Assessment of acute pain in farm animals using behavioral and physiological measurements. J. Anim. Sci. 75(1): 266-272.

Philipp, H., H. Schmidt, F. During and E. Salamon. 2001. Efficacy of meloxicam (Metacam®) as adjunct to a basic therapy for the treatment of diarrhoea in calves. Proceedings of the 11th International Conference on Production Diseases in Farm Animals. Acta Vet. Scand. Suppl. 98: 273 (Abstract).

Svensson, C., K. Lundborg, U. Emanuelson and S. Olsson. 2003. Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious iseases. Prev. Vet. Med. 58: 179-197.

Trotz-Williams, L.A., S.W. Martin, D. Martin, T. Duffield, K.E. Leslie, D.V. Nydam, F. Jamieson and A.S. Peregrine. 2005. Multiattribute evaluation of two simple tests for the detection of *Cryptosporidium parvum* in calf faeces. Vet. Pars. 143: 15-23.

USDA. 2002. Changes in the United States dairy industry, 1991-2002 USDA:APHIS:VS,CEAH, National Animal Health Monitoring System, Fort Collins, CO #N388.0603.

Waltner-Toews, D, S.W. Martin and A.H. Meek. 1986. Dairy calf management, morbidity and mortality in Ontario Holstein herds. IV. Association of management with mortality. Prev. Vet. Med. 4: 159-171.

2.7 Control of Coccidiosis in Calves

Bent Nielsen
Bayer Animal Health, Nørgaardsvej 32, DK-2800 Kgs. Lyngby, Denmark.

2.7.1 Abstract

Coccidia infections in cattle, primarily Eimeria bovis and Eimeria zuernii, are very common in Europe, including the Scandinavian countries. The impact of Eimeria infections varies considerably from farm to farm and region to region depending on environmental conditions, farm management practice, control of risk factors and medication. In case of treatment, choice of an active medical compound and time of treatment are essential to achieve the optimal protection for a sufficient long time. Toltrazuril (Baycox) combines a convenient one shot oral dose with efficient long time protection.

2.7.2 Sammendrag

Forekomsten af coccidie infektioner, typisk Eimeria bovis og Eimeria zuernii, er høj hos kalve i Europa, herunder Skandinavien. Den besætningsmæssige betydning af coccidie infektionerne varierer betydeligt fra besætning til besætning og fra region til region afhængig af miljø, management i besætningen, kontrol af risikofaktorer og medicinering. Valg af aktiv medicinsk præparat og behandlingsprotokol er afgørende for at opnå en optimal og langvarig beskyttelse ved behandlingen. Toltrazuril (Baycox) kombinere en let applicerbar 1 gangs oral behandling med høj effekt over lang tid.

2.7.3 Introduction

Diarrhea among calves is a common problem in many cattle herds world wide.
The most frequently isolated agents for diarrhea in Europe are E. coli, Rota and Corona virus, Cryptosporidium, Salmonella and not at least Coccidia.
Bovine coccidiosis has now been recognized as a serious disease in young cattle caused by protozoan parasites of the genus *Eimeria.* Coccidiosis is a multifactorial disease; the severity varies from sub-clinical cases without apparent symptoms to loose faeces for 1-2 days, severe diarrhea or even death. The economical looses from coccidiosis due to poor performance, mortality and treatment of secondary bacterial infections may be substantial. Several management factors can be control on herd level to reduce the severity of coccidiosis just as medication of calves can prevent the negative impact of Eimeria infections. This paper describes the prevalence of Eimeria in European cattle, the disease coccidiosis, herd management risk factors, and control of coccidiosis by medication.

2.7.4 Coccidia in European cattle

There are 12 known species of Eimeria which infect European cattle. Out of these, the two most pathogenic species are E. bovis and E. zuernii among cattle in stables, where as E. alabamensis is considered to be the most pathogenic coccidia in cattle on pasture (Daugschies et al, 2005).

Bayer (Bushan et al. 2006) recently conducted a European prevalence study in order to examine the prevalence of E. bovis and E. zuernii in dairy and veal calves after regrouping. The following countries were included in the study: Belgium, France, Germany, Hungary, Italy, The Netherlands, Poland and Spain.
Five percent of the regrouped animals in the age group 3 weeks to 9 months were screened on randomly selected farms. If the number of regrouped animals in the age group on a selected farm was less than 100, 10% of the calves were selected randomly. Animals that had received anticoccidial treatment in the preceding 4 weeks were excluded from the study. A total of 3.196 animals were examined. 10-15 gram of faeces were collected from each animal 3 weeks after regrouping and sent for coccidia oocysts examination at the laboratory using a salt flotation technique. If positive, the oocysts were identified on species level by examining their morphology and size under a light microscope at 100x to 400x magnification.
The results showed that all investigated countries had E. bovis and E. zuernii in calves. The herd level prevalence varied between 47% in the Netherlands to 100% in France and Poland. Of the 3.196 examined animals 18% were positive for E. bovis and 11% for E. zuernii. The prevalence of E. bovis varied between 6% (the Netherlands) to 38.4% (Poland) of tested animals, while the prevalence of E. zuernii varied between 2% (Netherlands) and 41.8% (Poland) of tested animals.

In a Danish study, Autzen et al. (2002) examined 292 calves in the age 1- 6 months from a total of 21 Danish dairy herds for the presence of coccidia. Eimeria oocysts were detected on all farms; the overall prevalence in calves was 88% with E. bovis as the most prevalent species (59% of calves).

In an ongoing Norwegian study in cattle, Eimeria species were isolated from 42% of the examined calves (n=872) less than 50 days of age (Østerås, 2007). Eimeria could be isolated from at least one calve in 94% of the investigated herds. E. bovis and E. zuernii was isolated from calves in stables and E. alabamensis was the most frequent isolated pathogenic coccidia on pasture. This observation is in concordance with a study from Sweden (Svensson et al. 1994) demonstrating E. alabamensis as a cause of diarrhea in calves on pasture.

2.7.5 Coccidiosis in calves

The calves becomes orally infected by sporulated oocysts from the environment and depended on the individual immune status, age of the animal, quantitative level of oocysts ingested and general robustness of the animal sub-clinical infection to clinical coccidiosis occur.
The coccidia life cycle has two phases. The exogenous phase where the oocysts are excreted in faeces and sporulated out side the animal, and the endogenous phase where the parasite proliferates in several stages in the intestinal epithelium, figure 1.

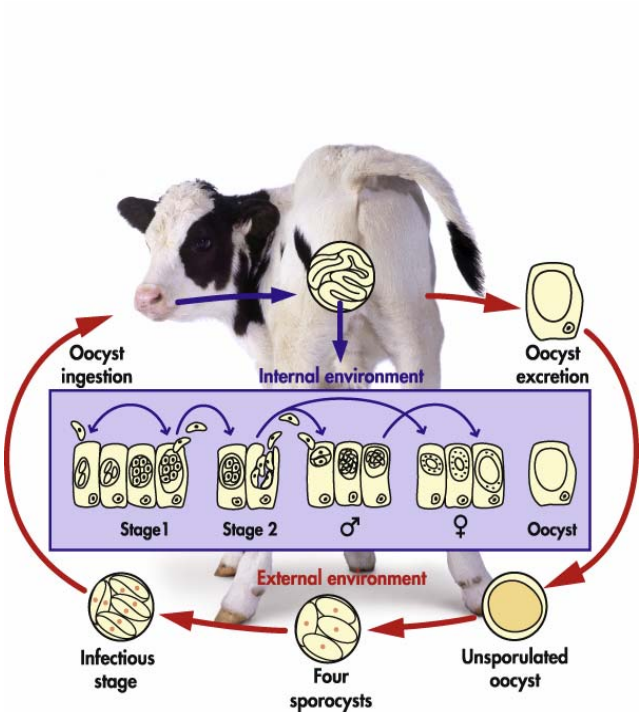
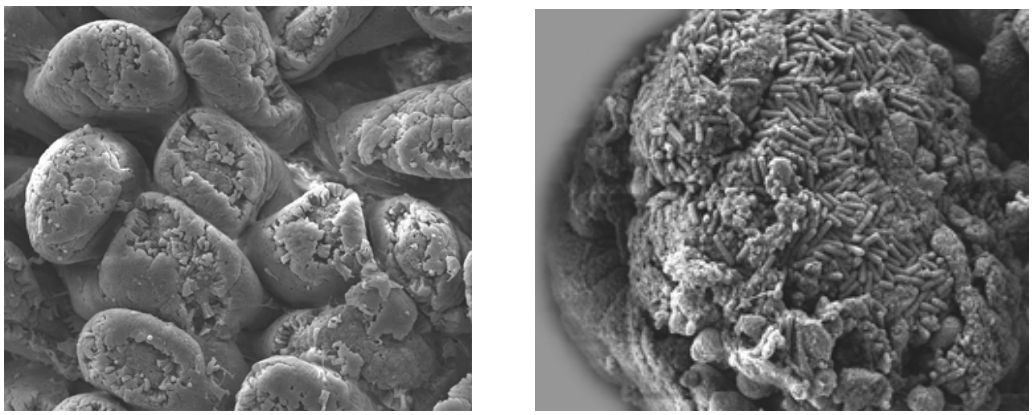


Figure 1. Schematic life cycle of Eimeria in cattle.

As a result of the proliferation in the intestinal epithelium the cells blasts, and creates massive superficial epithelial injuries in the intestines, figure 2a. Secondary bacterial infections may follow and exacerbate the gut injuries, figure 2b.



a b

Figure 2. Superficial epithelial injury in the ileum of a calf caused by E. zuernii (a), Secondary bacterial infection after coccidiosis (b).

Due to the intestinal injuries the animal will loose electrolytes, albumin, and blood and develop fibrin casts in the gut. The clinical symptoms are diarrhoea for several days. Some animals will develop severe enteritis with fibrin containing hemorrhagic faeces for weeks.
Both sub-clinical and clinical coccidiosis results in reduced growth of infected animals. However, it is impossible to predict which animals are going to suffer clinically in a herd.

2.7.6 Herd management risk factors

Eradication of coccidia infections on herd level is not possible due to the wide spread occurrence of Eimeria in the environment combined with the oocysts ability to survive for a

long time. However, several studies have demonstrated that by controlling certain risk factors on farm level, the level of coccidiosis can be reduced significantly:

- Calving pens must always be clean and dry
- Administration of 3-5 liter of colostrum is recommended within the first 24 hours of the calf's life to ensure general immune robustness
- The calf shed shall be cleaned, disinfected and dried intensively before the calves are transferred to the shed
- Drinking and feed equipment must always be clean and positioned to avoid faecal contamination
- Ensure no faecal contamination of feed
- Use hayrack to avoid faecal contaminated straw
- Avoid mixing of calves with older cattle
- Isolate sick animals as soon as possible, clean equipment used for sick animals effectively
- Fast and sufficiently medical treatment to sick animals to avoid the spread of infections

2.7.7 Prevention and control of coccidiosis

The establishment of a management program that strictly follows the described farm hygiene measures is in many farms sufficient to prevent problems with coccidiosis. However, the structure development with fewer but larger cattle farms increases the risk of coccidiosis as more and more calves are produced in the same stable. Additionally, the demand for new welfare friendly group pens with full body and faecal contact between calves increases the risk for coccidiosis. Consequently, the infection pressure may pass a critical level and induce coccidiosis in calves even in modern cattle farms.

In order to prevent a further increase in the coccidia load at the farm and to cure the sick animal's fast and efficient medical treatment is necessary.

Several different compounds have been used to treat coccidiosis in calves. Traditionally, sulfonamides have been used to treat acute clinical coccidiosis. The medication has to be applied for 5- 6 days in drinking water or given by an oral solution to ensure a sufficient level of treatment in each animal. Different in-feed premixed compounds have also been used, like decoquinate or monesin which needs to be given for 10-30 days continuously to ensure sufficient efficacy.

Toltrazuril (Baycox, Bayer Animal Health) is compared to the other compounds a new and efficient coccidiostat medicine. Toltrazuril is easy to use and apply as it only needs one oral dose to effectively prevent sub-clinical infection and clinical coccidiosis in calves, lamb and pigs. The one oral dose ensures a long lasting protection during the vulnerable time of the young animal. Toltrazuril is coccidiocide and kills all intracellular stages of coccidia in all parts of the intestine.

Timing of treatment is essential to achieve the optimal protection. Treatment during the prepatent period (the time from day of infection to start of oocysts excretion) ensures that animals will not suffer from clinical disease. The prepatent period differ among the coccidia species, table 1.

Table 1. Prepatent periods for Eimeria bovis, zuernii and alabamensis in cattle

Species	Prepatent period
E. bovis	17 - 22 days
E. zuernii	16 - 19 days
E. alabamensis	6 - 8 days

Coccidiosis is dynamic and insidious on a farm where different animals are at different stages of disease development depending on the infection dose and time of infection. However, the suitable time of treatment with Baycox can be calculated as approximately 1 week before anticipated clinical symptoms depending on the history of the farm, figure 3. All calves in the relevant age group and pens must be treated.

The mechanism of action, with activity against all intracellular stages of coccidia, and kinetic behavior of Toltrazuril with a long time presence in the body, give a wide intervention window. Furthermore, treatment with toltrazuril allows the animals to develop immunity to the actual coccidia, thus promoting resistance to a later exposure of coccidia.

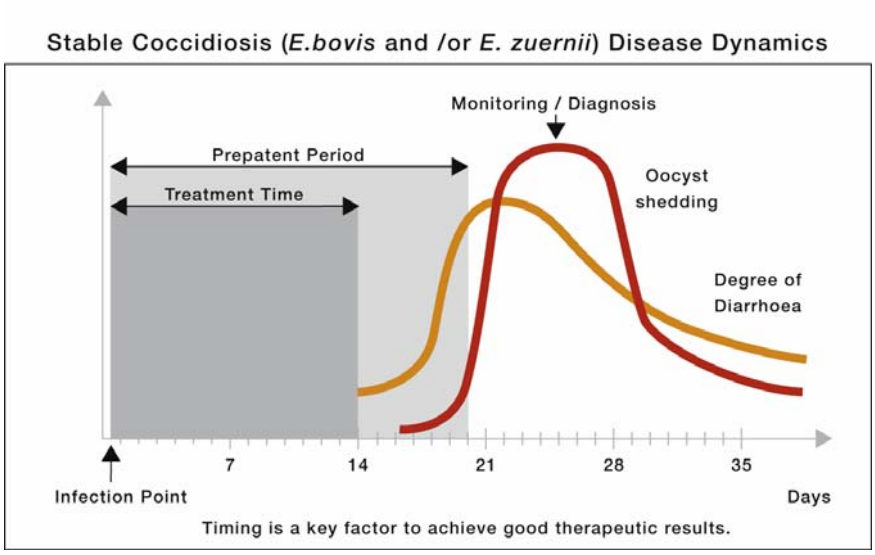


Figure 3. Treatment time for stable coccidiosis in calves must take place during the prepatent period to ensure optimal protection.

2.7.8 Discussion

Coccidia infections in cattle are very common in all Europe including the Scandinavian countries. The effect on productivity due to the coccidia infections varies considerably from farm to farm and region to region depending on environmental conditions, farm management practice, control of risk factors and medication. The poultry industry has for decades systematically been using coccidiostat's in order to avoid health problems. Today, coccidia control is nearly a precondition for been able to produce broilers in the modern industrialized production systems world wide.
During the last 10 years, European swine producers have experienced increasing problems with coccidia diarrhea in piglets due to Isospora suis. Today, most Danish swine producers

use Toltrazuril (Baycox) to control coccidiosis diarrhea in week 2 and 3, in order to prevent reduced growth and secondary bacterial infections at weaning. It may be speculated whether the increased prevalence of coccidiosis in piglets may reflect a true increase of Isospora suis, or alternatively a more pathogenic impact from previously unrecognized Isospora suis in piglets due to a more intensive production system like in the broiler industry.
Coccidia infections in calves appears so far to be an under reported disease as most diarrhea cases are considered to be due to Corona and Rota viruses or bacterial infections due to E. coli or Salmonella. Some of the new welfare group pens for calves are speculated to increase the risk for coccidiosis as many calves are in full body and faecal contact for weeks. It is important that veterinarians become aware that one of the main agents for diarrhea in these young animals is coccidia. Diagnosis of coccidiosis is a simple and fast process as faeces from infected animals contains a very high number of coccidia oocysts. Differentiation of the causal agents for diarrhoea is important in order to avoid unnecessary treatment with antibiotics in case of virus or coccidia infections, and also to use specific coccidiostat's in case of coccidia infections.
Coccidiosis in calves may be reduced be reducing the herd risk factors, mainly avoiding faecal material in feed, straw and water, egg. by use of a hayrack. However, this is no always sufficient and medical treatment is needed in problem herds to avoid severe health's problems.

2.7.9 Conclusion

Coccidia infections in calves are common and control of risk factors on herd level may reduce coccidiosis problems. Medical treatment with Baycox (Toltrazuril) effectively prevents and cures coccidia infection in calves.

2.7.10 Literature

Autzen, S., Maddox-Hyttel, C., Monrad, J., Vigre, H. 2002. Infection with Eimeria species in calves. Dansk Veterinærtidsskrift 2002, 85, 18, 15/9.

Bhushan, C., Figueiredo, M., Dominique, G., Malecki-Tepicht, J., Nisoli, L.,Perszo, J., Rierola, E., Szeidemann, Z., Torres, A., Westphal, B. 2006. Prevalence of Eimeria bovis and Eimeria zuernii in Europe. Extended Summaries 1st International Bayer Cattle Symposium, p. 8, Nice, France October 15th.

Daugschies, A., Najdrowski, M. 2005. Eimeriosis in cattle: current understanding. J. Vet Med B Infect Dis Public Health, 52: 417-427

Svensson, C., Uggla, A., Pehrson, B. 1994. Eimeria alabamensis infection as a cause of diarrhea in calves at pasture. Vet Parasitol, 53: 33-43

Østerås, O. 2007. Personal communication.

3 Beef calf raising

3.1 Krav til kalv i nyere ammekufjøs – erfaringer fra løsninger i nyere fjøs.

Elisabeth Kluften, Anders Bergum,
Nortura BA

3.1.1 Abstract:

There is an increasing interest of beef cattle production and the herd size also increase. The result is that more farmers build barns to the cattle because the existing barns dose not longer fit the size ore the type of production.. The calf is the product of the beef cattle production and loss of calf's influence the economic result. Good conditions for the calf are therefore important. Nortura advice service has done a study on new and existing barns to beef cattle and analyzed them according to facilities around calving and calf management.

The two main types of buildings that were analysed were deep litter and cubicle barns. The farmers that we asked had the calving in single box, something they meant was necessary. It varies if the cow was placed in the singe box before calving, under calving or just after calving. The cow spent one to five days in the single box depending of how many calving it was in the herd at the time.
All the farmers that were asked, pointed that calving box must be established flexible and practical so that they are easy to use. Calving boxes for more than one cow was not recommended and the size of the calving box was important.
Calf shelter should also be placed in a way that makes it easy for feeding and handling of the calf.

3.1.2 Sammendrag

Økende interesse for ammekuproduksjon og økt størrelse på besetningene gjør at flere investerer i fjøs til ammeku. Kalven er produktet i ammekuproduksjonen og tap av kalv går ut over det økonomiske resultatet. Gode forhold for kalven i fjøs til ammeku er derfor viktig.
I forbindelse med Nortura BA sitt rådgivnignstilbud på planlegging av fjøs til storfe og i forhold til gjeldende forskrifter, er det gjort en undersøkelse på erfaringer med fødebinger og kalvegjømme i de fjøsene som er bygd.
De to hovedtypene av fjøs som ble undersøkt var tallefjøs og liggebåsfjøs.
Av de som ble intervjuet lar de fleste kyrne kalve i enkeltbinger noe de mener er nødvendig. Det varierer om de setter kua i enkeltbinge før fødselen, når kalvinga starter eller rett etter kalving. Antall dager ku og kalv er i fødebinger varierer fra 1- 3 dager avhengig av hvor mange kyr som skal kalve i perioden. Alle de som ble intervjuet poengterte at det var en fordel at disse bingene var lett i tilgjengelige og at det var lagt til rette med ledegrinder slik at dyra kunne flyttes på en enkel og sikker måte. Det var ikke positive erfaringer med felles fødebinger og det ble hevdet at det var viktig at fødebingene hadde tilstrekkelig areal.
Det er fordelaktig med minimum en fødebinge som har funksjoner som ivaretar problemkuer. Disse funksjonene vil innebære fiksering, stort areal og grinder som ivaretar sikkerhet.

Erfaringene rundt kalvegjømme er at disse også bør plasseres slik at de er lett tilgjengelige i enden av fjøset med tanke på kraftfôrtildeling, håndtering og tilvenning.

3.1.3 Introduksjon

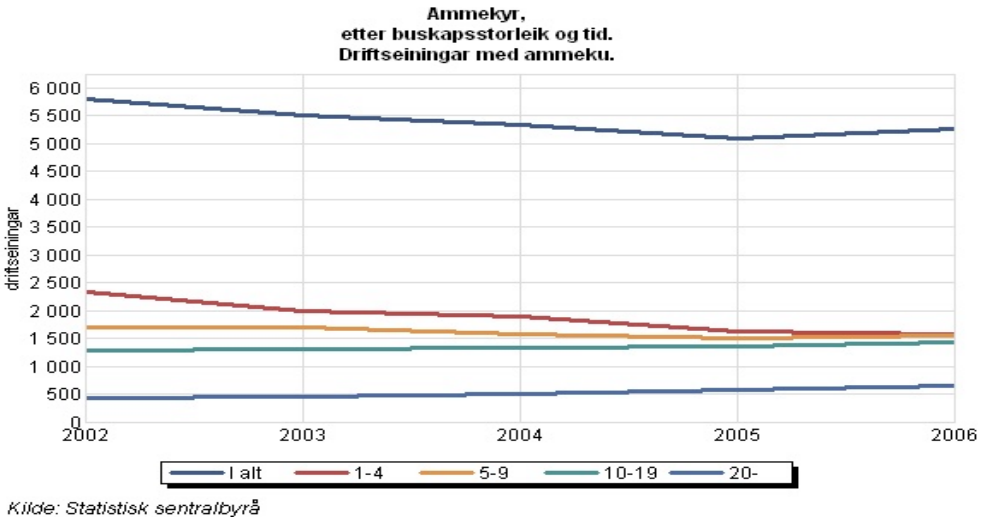
Det er sett på praktiske erfaringer fra både nybygde og ombygde fjøs til ammeku i forhold til oppstalling før, under og etter kalving. I tillegg er det sett på hvordan kalven ivaretas fra kalving til beiteslipp.
Målet var å se om produsentene var fornøyd med de løsninger og anbefalinger som ble gjort i planleggingsfasen og hvordan dette fungerer i forhold til gjeldende forskrifter og retningslinjer.
Ammekuproduksjonen i Norge består av ca 55.000 mordyr fordelt på 5250 besetninger (kilde, SSB, 2006). Besetningsstrukturen endrer seg i tillegg, det er en klar tendens til en økning i antall mordyr per besetning. Dette gir utfordringer i forhold til driftssystemer og rutiner. For å lykkes i denne produksjonen vil det være uhyre viktig å lykkes med arbeidsoppgavene rundt fødsel og perioden fram til avvenning.
Krav og regler, retningslinjer for hold av storfe krever et kalvgjømme har et areal på 0,7 m2/kalv og at alle skal kunne ligge samtidig. Krav til syke og fødebinge er en binge pr 25 mordyr. Størrelsen er anbefalt å være fra 8-10 m2 med korteste vegg på minimum 2,3 m.

3.1.4 Material og metoder

Hovedgrupper av fjøs som ble undersøkt var talleløsninger og liggebåsløsninger.
Det er benyttet data fra spørreundersøkelse (Norsk Kjøttfe, 2004-2005), knyttet til oppstallingsløsninger på ammeku. Det ble gjennomført besøk og intervju hos produsenter med de to hovedgruppene av fjøsløsninger. Felles for alle var at Nortura hadde vært involvert i planleggingen av disse fjøsene. Det ble spurt om hvilke erfaringer de hadde med løsningen, hva som fungerte bra og dårlig i tilknytting til valgte løsning. Det ble også spurt om hva som kunne vært gjort bedre for å få den optimale løsningen.
Kalvingsperioden for besetningene strekker seg i hovedsak fra februar til april, men det er også en besetning som fordeler kalvingen på 2 puljer med 6 måneders intervall.
Besetningsstørrelsen varierer fra 20 til 90 ammekyr. Besetningene er både kombinerte og spesialiserte.

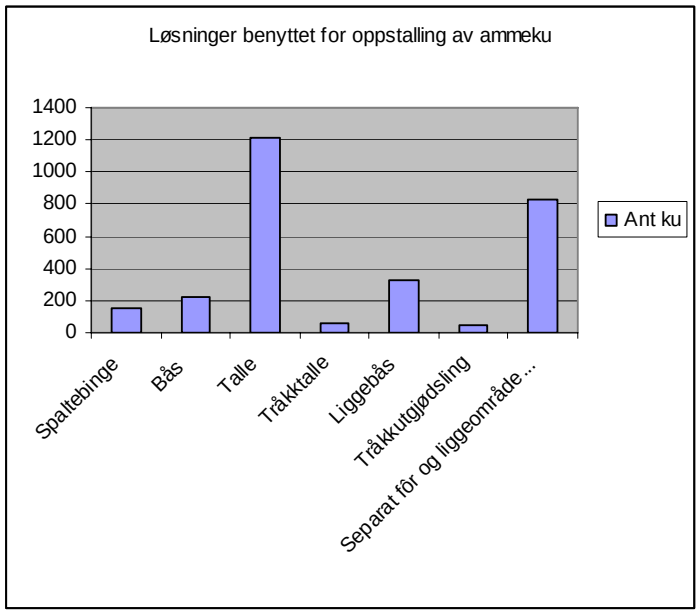
3.1.5 Resultater

Utviklingstrekk i den norske ammekustrukturen, figur 1. Besetninger som har mer enn 10 mordyr representerer 76 % av mordyrtallet og 57 % av besetningene. Figur 1 viser også at det er bare disse gruppene som er økende, størst økning er det i besetninger med mer enn 20 mordyr.



Figur 1 Utviklingstrekk i den norsk ammekustrukturen

Figur 2 viser fordelingen av ulike løsninger benyttet til ammeku. Det er i all hovedsak ulike løsninger med talle som er benyttet.. Resultatene fra undersøkelsen viser at ca 71 % av ammekyrne oppstalles i talleløsning mens liggebås representerer ca 11 %. Figur 1 viser fordelingen av løsninger innhentet fra leverandører til varmstrømmen Norsk Kjøttfe 2004 - 2005.



Figur 2 Fordelingen av ulike løsninger benyttet til ammeku

Produsentene vi intervjuet
Besetningene med talle hadde fra ca 40 til 90 mordyr.
Det varierte hvorvidt ammekua kalvet i fellesarealet eller om den ble sluset ut i egen fødebinge. Felles for produsentene var at de prøvde å sette ammekua i egen fødebinge når de registrerte at kalvingen nærmet seg. En av produsentene poengterte behovet for egen fødebinge til kviger. Disse trenger mer ro rundt kalving og det er en fare for at eldre mordyr kan prøve å "overtar" kalven med de problemer dette medfører. Den største besetningen benyttet lettgrinder inne i fellesarealet som fødebinge. Han hadde gode erfaringer med dette, i denne besetningen ble alle satt i fødebinge før kalving.

Antall fødebinger
Dette varierte mellom besetningene, de som benytter seg av lettgrinder er ganske fleksible. Det er først og fremst talleløsninger som benytter dette, men også noen av besetningene med liggebås benyttet seg av tilgjengelig friareal til fødebinger med lettgrinder. Ingen påpekte at de hadde i minste laget med fødebinger. Antall permanente fødebinger varierte fra 1 binge per 10 ammekyr til 1 binge per 25 ammekyr. De med færrest fødebinger hadde mulighet for etablering av fleksible fødebinger slik at det i praksis gjenspeilte behovet.

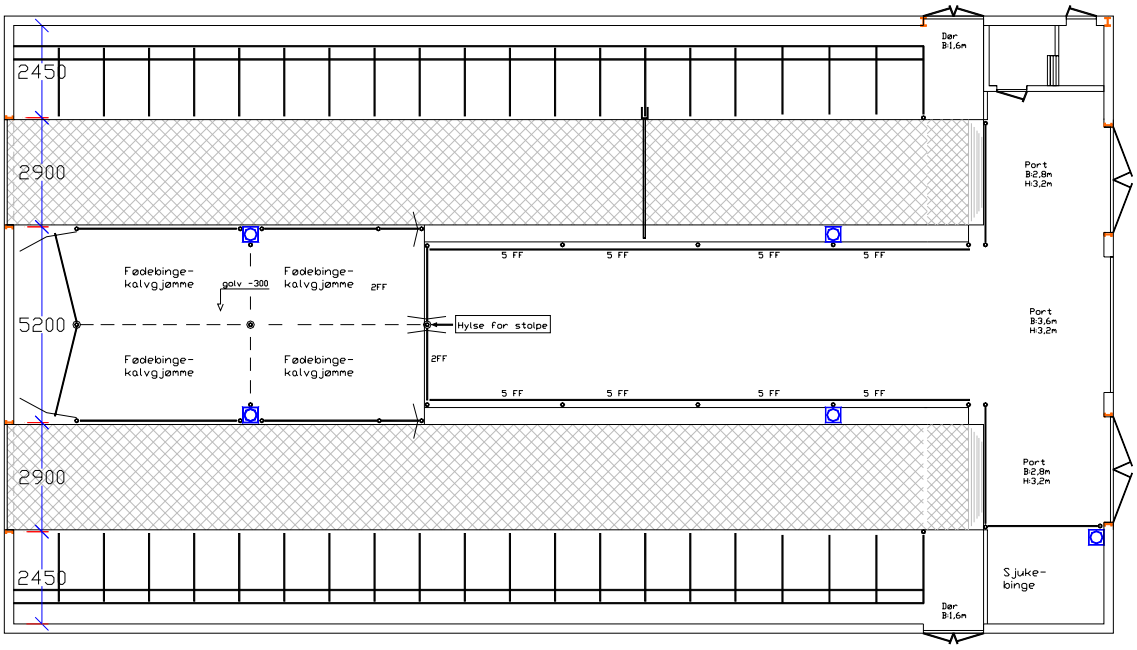
Underlag i fødebingen
Underlaget i fødebingen besto i all hovedsak av halm. Noen velger å skifte alt strø mellom hver kalving, men i praksis strør de aller fleste ny halm opp på den gamle. Den yngste produsenten i alder og erfaring var den som skiftet oftest halm i bingene.

Logistikk
Bruken av fødebingen varierer, men de fleste produsentene benyttet fødebingen i tre dager,
Noen produsenter benyttet fødebingen så lenge den var tilgjengelig. Et viktig moment flere produsenter påpekte var god grinder og ledeganger slik at ammekua på en sikker og enkel måt kunne føres trygt til fødebingen.

Utforming og plassering
Hovedløsningene som er undersøkt er enten talle eller liggebåsfjøs. De fleste benyttet seg av fødebinger og kalvgjømmer som er plassert i enden av fjøset. De som ble intervjuet utrykte at de var fornøyd med denne plasseringen. Fellesbinger hvor flere ammekyr går sammen var det mindre gode erfaringer med. Det var et ønske at denne type binger kunne splittes til enkelbinger.

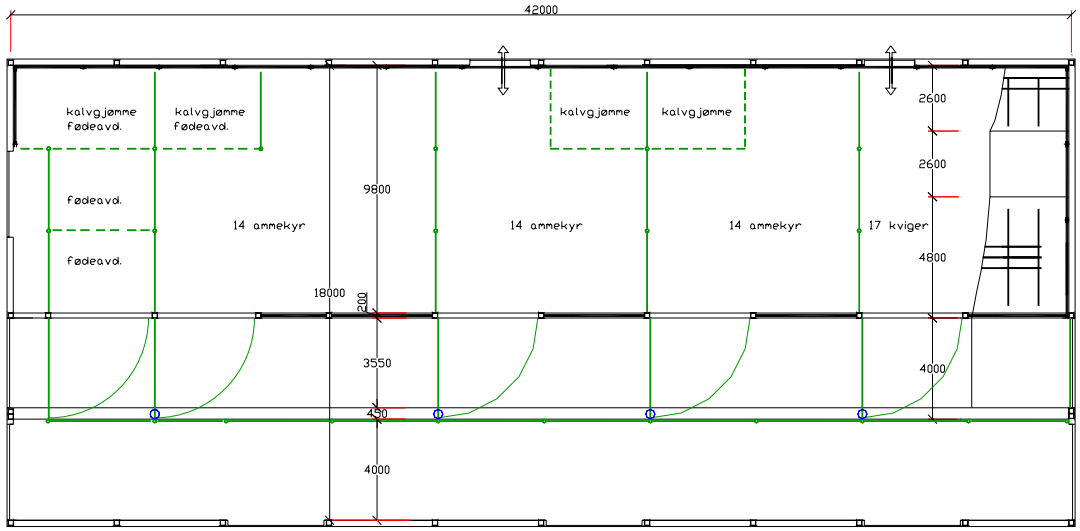
Kalvgjømme
Når det gjelder kalvegjømme er dette ofte fødebingen som omdisponeres etter at hoveddelen av kalvingen er unnagjort. Dette gjelder både for løsninger med talle og liggebås. Produsentene påpekte at det var fordelaktig med plassering i enden av fjøset slik at arbeidsoppgaver som preging, tildeling og av kraftfôr, avhorning etc kan skje enkelt. Alle produsentene tildelte kraftfôr i kalvgjømme. Noen av kalvegjømmene hadde eget drikkekar.

Planløsninger for noen av de fjøsene som ble undersøkt og som representerer hovedprinsipppene.



Figur 3**:** Liggebåsfjøs

Liggebåser og fødebinger/kalvgjømme i enden av fôrbrett. To av fødebingene har direkte tilgang til fôrbrett, disse er i tillegg utstyrt med fanghekk.



Figur 4**:** Tallefjøs

Talleløsning hvor fødeavdeling er plassert i enden av bygget. Løsningen muliggjør ombygging til liggebås slik som illustrert til høyre på tegningen. Tre av de fjøsene som ble undersøkt var basert på denne modellen.

3.1.6 Diskusjon – konklusjon

Det er viktig med fleksible løsninger i forhold til etablering av fødebinger. Det å kunne ta i bruk friareal til fødebinger anses som fordelaktig. I perioder kan det være mange kalvinger, de aller fleste vil da ha behov for å etablere nye binger med bruk av lettgrinder.

Fødebingene må være lett tilgjengelig i forhold til nødslakt, dyrlege, fôr og tilsyn. Arbeidsoperasjonene med bæring av grovfôr og kraftfôr bør være så lite arbeidskrevende som mulig. Skulle det oppstå komplikasjoner er tilgjengeligheten viktig. Det er i tillegg gunstig med plassering i nærheten av servicerom med hensyn til tilsyn. Plassering i nærhet til der røkter beveger seg mye gjør også at preging av kalven skjer i større grad. Dette gjelder både fødebinge og kalvgjømme.

Trygg og sikker håndtering. Ei god ammeku har et sterkt morsinnstinkt, noe som kan være en risiko for røkter. Det er derfor viktig med gode ledegrinder, ganger og mulighet for fiksering i selve fødebingen.

Halm foretrekkes som underlag, dette er i samsvar med kjent kunnskap om halm sin evne til å isolere samtidig som halmen er skånsom mot hud. Hygienen bestemmes av produsent ved gode rutiner med strø.

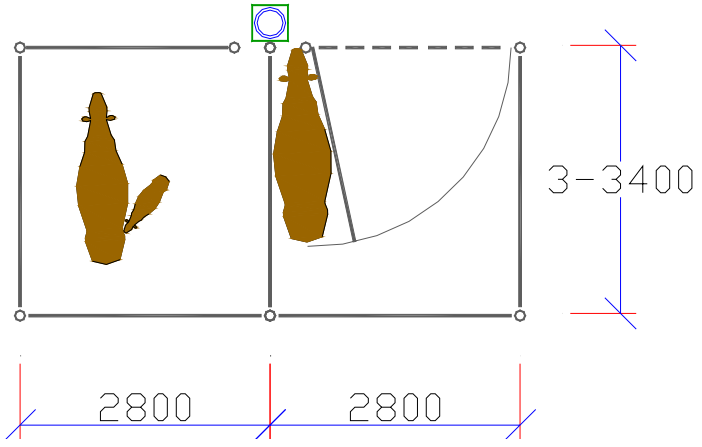
Produsentene ønsker å benytte enkeltbinger med tilstrekkelig areal. Retningslinjer er her ikke i forhold til hva denne produksjonen krever. Ammekuproduksjonen er en produksjon hvor arealet er viktig i kalvingssesongen det samme tilgang på antall fødebinger.

Bruken av fødebingen i tid. Produsentene benyttet fødebingen i tre til fem dager, dette er i samsvar med våre anbefalinger. Det er ønskelig at ku og kalv kan gå i fødebingen til navlestrengen har tørket, samtidig som det er etablert et godt forhold mellom ku og kalv.

Ingen av produsentene uttrykte mangel på areal til kalvgjømme også dette bør plasseres i enden av fjøset. Dette gir flere fordeler, blant annet forenkler dette tilgang til selve bingen, tildeling av fôr , videoovervåking og situasjoner der nødslakt er eneste løsning.

Det er fordelaktig med minimum en fødebinge som har funksjoner som ivaretar problemkuer. Disse funksjonene vil innebære fiksering, stort areal og grinder som ivaretar sikkerhet.

Figuren viser fødebinge med mulighet for fiksering. Selve fikseringen skjer ved å skyve en grind mellom røkter og dyret. Dette gjør at sikkerheten ivaretas. Det er viktig med dybde i bingen slik at fødselshjelp kan utføres.



Figur 5: Fødebinge

4 Feeds and feeding

4.1 Gastrointestinal Development in Dairy Calves

A. J. Heinrichs
Dairy and Animal Science Department
The Pennsylvania State University
University Park, PA 16802

4.1.1 Abstract

The nutrient content of the diet of the young calf is very specific and critical because much of the gastrointestinal physiology of the newborn calf is poorly developed at birth and the neonate is unable to digest a variety of feedstuffs normally fed to adult ruminant animals. The gastrointestinal tract of newborn calves must undergo some maturation during the first three or more weeks of life and it continues to grow and mature for an extended period of time in the young heifer. This paper will outline the physiological and gastric changes that occur it the newborn dairy calf during the first few weeks of life to show how these impact how we need to feed and manage the dairy calf properly.

4.1.2 Sammendrag

Innholdet av næringsstoffer i rasjonen til unge kalver må være nøye tilpasset fordi mye av fordøyelsesmekanismene i mage- tarmsystemet er dårlig utviklet hos den nyfødte kalven. Det er en rekke fôrmidler som normalt brukes til voksne drøvtyggere, som den nyfødte kalven ikke kan fordøye. Mage- tarmsystemet må utvikles i de første tre eller flere ukene av livet til en nyfødt kalv og siden modnes i en lang periode av dyret liv. Denne artikkelen presenterer fysiologien og mage-tarmsystemets endringer de første ukene hos den nyfødte kalven. Det diskuteres videre hvordan vi må fôre kalven og organisere kalveoppdrettet for å oppnå god utvikling av fordøyelsessystemet

4.1.3 Results and discussion

Gastric Enzymes in the Dairy Calf
The role of gastric enzymes is important for the digestion of the diet of the young ruminant animal due to its undeveloped rumen and reliance on the abomasum and small intestine for nutrient digestion and assimilation. The ability of neonates to digest and utilize high concentrations of milk fat, especially with low concentrations of intestinal lipases, is due to a combination of enzymes called pregastric esterase (Huber et al., 1961). This complex of lipolytic enzymes provides the majority of lipid breakdown within the abomasum, similar to salivary α-amylase in monogastrics. Pregastric esterase is composed of at least 6 different enzymes secreted from four areas of the glosso-epiglottic area of the mouth, including the vallate papillae region of the tongue, the glosso-epiglottic area, the pharyngeal end of the esophagus and the submaxillary salivary gland (Moreau et al., 1988; Ramsey et al., 1956). It is of interest to note that adult ruminants in general, are not capable of digesting diets high in fat yet it is one of the main components in the diet of a neonatal ruminant.

Although the term pregastric esterase is commonly used to describe esterases (defined as enzymes capable of hydrolyzing esters in solution) it also contains lipases which have a more specific role in digestion (defined as specialized esters that hydrolyze fatty acids from water insoluble glycerol esters). Pregastric esterase has become the common term for enzymes of lipolytic or esterolytic nature secreted by mammalian oral tissues (Nelson et al., 1960).

Pregastric esterase is stimulated by nursing in the young calf (Huber et al., 1961; Moreau et al., 1988; Ramsey and Young, 1961a). During clotting of milk that occurs after ingested milk reaches the abomasum in young ruminants, pregastric esterase begins the breakdown of lipids within the casein clot (Bondi, 1987; Hill et al., 1970). Pregastric esterase hydrolyzes about 20% of all milk fat glyceride linkages, mainly short chain fatty acids, indicating its role in lipolysis (Bondi, 1987; Hill et al., 1970; Pitas and Jensen, 1970).

The preference of pregastric esterase for glyceride linkages of butyric acid has been reported to result in 59% of butyrate linkages hydrolyzed in vitro as compared with 7% of higher fatty acids (Ramsey and Young, 1961b). Butyric acid is highly soluble in water and is hydrolyzed faster than longer chained fatty acids, passing quickly from the abomasum to the small intestine. Breakdown of butyric acid and other fatty acids is higher in milk fed orally than milk that is infused into the abomasum indicating pregastric esterase is required (Otterby et al., 1964a; Otterby et al., 1964b; Russell et al., 1980). Other, less soluble, fatty acids are trapped by curd particles and slowly migrate to the small intestine (Otterby et al., 1964a; Ramsey and Young, 1961a). Although pregastric esterase plays a primary role in lipolysis in the abomasum, calves fed only through infusion of milk into the abomasum, decreasing stimulation of pregastric esterase secretion, were still able to digest milk fat most likely by pancreatic lipase action (Russell et al., 1980).

Pregastric esterase may also be found in the digesta of the small intestine, which was thought to indicate a role in intestinal digestion of lipids (Otterby et al., 1964b). Later work reported that pregastric esterase has a diminished effect once it enters the duodenum and no effect at all if pancreatic enzymes are not present (Gooden, 1973).

A small part of lipolysis in the abomasum was reported to exist in part from a gastric lipase secreted directly from abomasal tissues. Toothill et al. (1976) used abomasal pouch secretions to prevent oral or pancreatic contamination and found no lipolytic digestion, concluding that lipolysis in the abomasum is solely due to pregastric esterase. Other researchers also concluded that gastric lipase is similar to pregastric esterase and must have been mistakenly identified as a separate enzyme (Nelson et al., 1960; Otterby et al., 1964b).

Although most of the enzymes in the alimentary tract of the young calf seem underdeveloped, enzymes that primarily coagulate milk protein are produced in high concentrations. Chymosin, pepsin and hydrochloric acid coagulate milk, retaining casein and fat and allowing nutrients to slowly pass into the small intestine (Cruywagen et al., 1990; Guilloteau et al., 1983; Guilloteau et al., 1984). Chymosin, formerly called rennin, is found in high concentrations in the newborn calf and lamb and decreases with age and at weaning (Cybulski and Andren, 1990; Guilloteau et al., 1983; Guilloteau et al., 1984; Guilloteau et al., 1985). However, calves kept on milk for an extended period of time retain higher chymosin concentrations than weaned calves indicating abomasal enzymes are regulated by development of the rumen as well as high concentrations of lipids and casein in the diet (Cybulski and Andren, 1990; Guilloteau et al., 1985).

The bovine abomasum secretes at least 3 proteases, including pepsin A, pepsin B (also known as gastricsin or pepsin II), and chymosin, all secreted as proenzymes from the mucous cells of

the pyloric and fundic glands and requiring a pH of less than 4 to become active (Cybulski and Andren, 1990). Pepsin A is found in high concentrations at birth and remains constant with increasing age of both calves and lambs (Guilloteau et al., 1983; Guilloteau et al., 1984; Guilloteau et al., 1985), until about 44 days (Huber et al., 1961). After weaning, the ratio of pepsin to chymosin increases due to digestion needed of protein for solid feed rather than casein (Cybulski and Andren, 1990; Guilloteau et al., 1983; Guilloteau et al., 1985). Pepsin A and chymosin adequately coagulate milk in the abomasum of the young calf and therefore, pepsin B is not found until weaning, when concentrations of chymosin decrease and the pH of the abomasum acquires a broader range due to varied feed (Cybulski and Andren, 1990). The potential for pepsin, trypsin, chymotrypsin and amylase to be secreted from the pancrease increases as the amounts of starch and protein increase in the diet (Garnot et al., 1977; Guilloteau et al., 1985). Therefore these generally increase with age and increasing dry matter intake of grains in the diet.

Pancreatic Enzymes

During the first two days of life, high concentrations of abomasal enzymes clot colostrum and allow immunoglobulins to pass into the small intestine. Pancreatic enzymes are found in low concentrations at birth until 2 days of age in young ruminants, allowing immunoglobulins to remain intact. It is not until after 2 days of age that concentrations begin to increase until around 42 days of age (Guilloteau et al., 1983; Guilloteau et al., 1984).

Pancreatic amylase is a glycosidic enzyme found in the small intestine, making up 5-6% of total protein in human pancreatic secretions (Lowe, 1994). However, in ruminants, only 2% of total protein in pancreatic secretions is α-amylase indicating a decreased intestinal ability to hydrolyze starch (Keller et al., 1958). Starch is not part of the diet of milk-fed ruminants and mature ruminants are able to hydrolyze starch in the rumen. Pancreatic amylase is found at low levels in the newborn and increases with age (Guilloteau et al., 1984; Huber et al., 1961; Le Huërou et al., 1992; Morrill et al., 1970).

Pancreatic fluid also contains two nucleases, deoxyribonuclease I (DNase) and ribonuclease (RNase). Although there is little known about both, RNase is required in weaned calves to recover phosphorus from bacterial RNA (Lowe, 1994).

Unlike other pancreatic enzymes, all peptidases are secreted as zymogens or proenzymes. The main activator of pancreatic peptidases, trypsinogen, is also secreted as a proenzyme and is cleaved by enteropeptidase to the active form of trypsin. Trypsin then cleaves other proenzymes, including chymotrypsinogen, procarboxypeptidase A, procarboxypeptidase B and procolipase, to their active forms of chymotrypsin, carboxypeptidase A and B and colipase (Lowe, 1994). Trypsin amounts secreted in pancreatic juice are low in the newborn ruminant and increase with age during the first two to four weeks in both the lamb and the calf. Chymotrypsin is higher in the young animal than trypsin but the ratio decreases with age (Guilloteau et al., 1983; Guilloteau et al., 1984; Huber et al., 1961).

Pancreatic lipases, such as colipase and phospholipase A2, are low at birth and then increase and remain constant (Gooden, 1973; Guilloteau et al., 1984; Huber et al., 1961; Le Huërou et al., 1992). These lipases are highly active at a pH of 8.5 and specifically hydrolyze triglycerides and phospholipids. Guilloteau et al. (1984) reported that from birth until 3 weeks of age, the colipase/lipase ratio is higher than one indicating pancreatic activity is entirely expressed in pancreatic juice in the intestinal lumen. Although calves one to two weeks of age have a diminished capacity to absorb lipids if pancreatic enzymes are removed, there still remains lipolytic activity in the intestinal lumen (Gooden, 1973; Gooden and

Lascelles, 1973). This is most likely due to enzymes present in the brush border of intestinal villi.

Brush Border Enzymes

There are many peptidases found in the microvilli of enterocytes. The main hydrolases found in the brush border are aminopeptidase N, aminopeptidase A, and dipeptidyl peptidase IV (Le Huërou-Luron, 2002). All of these peptidases are designed to cleave specific terminal amino acids from proteins (Palmer, 1995). Aminopeptidase N hydrolyzes peptides in a stepwise manner up to a certain point at which dipeptidyl peptidase IV finishes the hydrolysis (Le Huërou-Luron, 2002). Aminopeptidase A, aminopeptidase N, and alkaline phosphatase are highest in the calf until 2 days of age and then decrease until 1 week of age. They remain constant until weaning, at which they increase (Le Huërou et al., 1992).

There are four major disaccharidases found in the brush border of the small intestine, including maltase-glucoamylase, sucrase-isomaltase, lactase, and trehalase(Le Huërou-Luron, 2002). Sucrase-isomaltase is not present in cattle and addition of sucrose to the diet of young ruminants causes an increase in scours (Huber et al., 1961; Le Huërou et al., 1992; Le Huërou-Luron, 2002).

Maltase-glucoamylase hydrolyzes α(1-4) glucosidic bonds whereas isomaltase hydrolyzes α(1-6) glucosidic bonds (Le Huërou-Luron, 2002). Maltase concentrations are low at birth and increase between 7 and 119 days after birth. Isomaltase is at low concentrations in the newborn and increases after weaning (Le Huërou et al., 1992). Trehalase, one of the four disaccharidases is able to hydrolyze trehalose to produce free monomeric glucose for absorption (Le Huërou-Luron, 2002).

Lactase is the only enzyme capable of hydrolyzing β(1-4) glucosidase and β(1-4) galactosidase activity. It is able to break down lactose to glucose and galactose as well as cellobiose to two monomers of glucose (Le Huërou-Luron, 2002). Lactase activity is highest at birth and decreases until about 3 weeks of age (Huber et al., 1961) or 1 week of age (Le Huërou et al., 1992) and then remains constant until levels drastically decline at weaning. However, feeding a diet high in lactose does not alter lactase concentrations (Huber et al., 1961).

Although digestive enzyme concentrations are dependent on age of the calf, early researchers reported digestive enzyme secretions are not affected by diet of the calf (Guilloteau et al., 1983; Guilloteau et al., 1984; Huber et al., 1961; Young et al., 1960). More recent work has found alterations in secretions of digestive enzymes when different sources of protein are used in milk replacers. Unprocessed soy protein in milk replacers often alter intestinal morphology by decreasing absorptive surface area of intestinal villi as well as concentration of disaccharidases in the brush border (Pederson and Sissons, 1984). Trypsin and chymotrypsin secretions are also inhibited by allergens and anti-trypsin factors in soy protein when ingested by the young calf (Gorrill et al., 1967; Guilloteau et al., 1986; Mir et al., 1991). Soy protein may be included in milk replacer fed to calves older than 20 days of age in low concentrations but must be processed to decrease concentrations of potential allergens as well as increase protein digestibility (Mir et al., 1991).

Digestibility of milk replacer is affected by other additions, such as using high concentrations of starch as alternative energy sources. Incorporating starch into milk replacer for preruminants is not recommended due to low concentrations of pancreatic amylase present in the intestine. Starch contains 17-30% amylose and 70-83% amylopectin. Amylose consists of glucose units arranged in a linear polymer bound with α-(1,4) glycosidic linkages and

amylopectin is bound by α-(1,6) branch points along the α-(1,4) linked glucose polymer. These bonds must be broken before absorption can occur and the low concentrations of pancreatic amylase present do not hydrolyze enough bonds to provide adequate energy for the calf (Morrill et al., 1970). However, once the calf is older and the rumen is more developed, starch becomes a primary part of the diet. Development of the rumen including formation and elongation of rumen papillae is critical in transforming the monogastric calf to the ruminant dairy heifer (Church, 1988). More economical diets and reduced labor required for feeding are the driving forces to demand this change as early as possible. The primary limiting factor for weaning dairy calves from milk or milk replacer is having adequate development of the rumen in order to maintain post weaning growth at desired rates.
Rumen development is stimulated by the presence of microbial produced volatile fatty acids, primarily butyric acid (Beharka et al., 1998; McLeod and Baldwin, 2000). Volatile fatty acids introduced into the rumen as purified sodium salts, especially sodium butyrate, increase epithelial development (Tamate et al., 1962). Butyric acid provides energy for the rumen wall for maintenance and development. This development includes the formation of papillae and thickening of the rumen wall, including increased capillary development (Weigand et al., 1975). Any additional butyric acid that is not needed as energy for the rumen is transported into the blood stream as beta-hydroxybutyrate. Around ninety percent of butyrate produced in the rumen is directly absorbed (Bergman, 1990; Weigand et al., 1975). Rumen wall growth and capillary development are needed to increase the ability of this organ to absorb rumen produced energy substrates. Since the microbial end products of starch are propionic and butyric acids, rumen development is most influenced by ingestion of grain and the digestion of the starch components in the grain. When starch is broken down in the rumen, volatile fatty acids (VFAs) are produced. (Greenwood et al., 1997; Krehbiel et al., 1992; Nocek et al., 1984; Weigand et al., 1975).

4.1.4 Conclusions

In summary, the enzyme systems of the neonatal dairy calf are quite complex, yet well suited for an animal that begins life as a monogastric and is transformed to a ruminant. The development of the rumen is paramount in importance from a modern-day management standpoint where economics and labor management are limiting factors on progressive dairy farms.

4.1.5 Literature

Beharka, A. A., T. G. Nagaraja, J. L. Morrill, G. A. Kennedy, and R. D. Klemm. 1998. Effects of form of the diet on anatomical, microbial, and fermentative development of the rumen of neonatal calves. J. Dairy Sci. 81:1946–1955.

Bergman, E. N. 1990. Energy contributions of volatile fatty acids from the gastrointestinal tract in various species. Physiol. Rev. 70:567–590.

Bondi, A. A. 1987. The nutritional requirements for production of body gain. Pages 370–412 *in* Animal nutrition. John Wiley & Sons, Chichester.

Church, D. C. 1988. The Ruminant Animal Digestive Physiology and Nutrition. 1 ed. D. C. Church, ed. Prentice Hall, Englewood Cliffs, NJ.

Cruywagen, C. W., G. J. Brisson, and H. H. Meissner. 1990. Casein curd-forming ability and abomasal retention of milk replacer components in young calves. J. Dairy Sci. 73:1578–1585.

Cybulski, W., and A. Andren. 1990. Immunohistochemical studies on the development of cells containing progastricsin (minor pepsinogen) in comparison to prochymosin and

pepsinogen in Bovine abomasal mucosa. Anat. Rec. 227:458–463.
Garnot, P., R. Toullec, J. L. Thapon, P. Martin, M.-T. Hoang, C. M. Mathieu, and B. Ribadeau-Dumas. 1977. Influence of age, dietary protein and weaning on calf abomasal enzymic secretion. J. Dairy Res. 44:9–23.
Gooden, J. M. 1973. The importance of lipolytic enzymes in milk-fed and ruminating calves. Aust. J. Biol. Sci. 26:1189–1199.
Gooden, J. M., and A. K. Lascelles. 1973. Relative importance of pancreatic lipase and pregastric esterase on lipid absorption in calves 1-2 weeks of age. Aust. J. Biol. Sci. 26:625–633.
Gorrill, A. D. I., J. W. Thomas, W. E. Stewart, and J. L. Morrill. 1967. Exocrine pancreatic secretion by calves fed soybean and milk proteins diets. J. Nutrition. 92:86–92.
Greenwood, R. H., J. L. Morrill, E. C. Titgemeyer, and G. A. Kennedy. 1997. A new method of measuring diet abrasion and its effect on the development of the forestomach. J. Dairy Sci. 80:2534–2541.
Guilloteau, P., T. Corring, J. A. Chayvialle, C. Bernard, J. W. Sissons, and R. Toullec. 1986. Effect of soya protein on digestive enzymes, gut hormone and anti-soya antibody plama levels in the preruminant calf. Reprod. Nutr. Develop. 26 (2 B):717–728.
Guilloteau, P., T. Corring, Pascaline Garnot, P. Martin, R. Toullec, and G. Durand. 1983. Effects of age and weaning on enzyme activities of abomasum and pancreas of the lamb. J. Dairy Sci. 66:2373–2385.
Guilloteau, P., T. Corring, R. Toullec, and R. Guilhermet. 1985. Enzyme potentialities of the abomasum and pancreas of the calf. II. Effects of weaning and feeding a liquid supplement to ruminant animals. Reprod. Nutr. Develop. 25:481–493.
Guilloteau, P., T. Corring, R. Toullec, and J. Robelin. 1984. Enzyme potentialities of the abomasum and pancrease of the calf. I. Effect of age in the preruminant. Reprod. Nutr. Develop. 24:315–325.
Hill, K. J., D. E. Noakes, and R. A. Lowe. 1970. Gastric digestive physiology of the calf and piglet. Pages 166–179 in Physiology of Digestion and Metabolism in the Ruminant. Phillipson, ed. Oriel Press, New Castle.
Huber, J. T., N. L. Jacobson, and R. S. Allen. 1961. Digestive enzyme activities in the young calf. J. Dairy Sci. 44:1494–1501.
Keller, P. J., E. Cohen, and H. Neurath. 1958. The proteins of bovine pancreatic juice. J. Biol. Chem. 346:344–349.
Krehbiel, C. R., D. L. Harmon, and J. E. Schnieder. 1992. Effect of increasing ruminal butyrate on portal and hepatic nutrient flux in steers. J. Anim. Sci. 70:904–914.
Le Huërou, I., P. Guilloteau, C. Wicker, A. Mouats, J. A. Chayvialle, C. Bernard, J. Burton, R. Toullec, and A. Puigserver. 1992. Activity distribution of seven digestive enzymes along small intestine in calves during development and weaning. Dig. Dis. Sci. 37:40–46.
Le Huërou-Luron, I. 2002. Production and gene expression of brush border disaccharidases and peptidases during development in pigs and calves. Pages 491–513 *in* Biology of the intestine in growing animals. First ed. R. Zabielski, P. C. Gregory, and B. Weström, ed. Elsevier Science.
Lowe, M. 1994. Structure and function of pancreatic enzymes. Pages 1531–1542 in Physiology of the Gastrointestinal Tract. L. R. Johnson, ed. Raven Press, New York.
McLeod, K. R., and R. L. Baldwin. 2000. Effects of diet forage: concentrate ratio and metabolizable energy intake on visceral organ growth and in vitro oxidative capacity of gut tissues in sheep. J. Anim. Sci. 78:760–770.
Mir, P. S., J. H. Burton, and J. G. Buchanan-Smith. 1991. Nutritional performance of calves fed milk replacers containing processed soybean products. Can. J. Anim. Sci. 71:97–106.
Moreau, H., Y. Gargouri, D. Lecat, J. L. Junien, and R. Verger. 1988. Screening of

preduodenal lipases in several mammals. Biochim. Biophys. Acta. 959:247–252.
Morrill, J. L., W. E. Stewart, and R. J. McCormick. 1970. Pancreatic amylase secretion by calves. J. Dairy Sci. 53:72–78.
Nelson, J. H., R. G. Jensen, and R. E. Pitas. 1960. Pregastric esterase and other oral lipases-a review. J. Dairy Sci. 60:327–362.
Nocek, J. E., C. W. Heald, and C. E. Polan. 1984. Influence of ration physical form and nitrogen availability on ruminal morphology of growing bull calves. J. Dairy Sci. 67:334–343.
Otterby, D. E., H. A. Ramsey, and G. H. Wise. 1964a. Lipolysis of milk fat by pregastric esterase in the abomsum of the calf. J. Dairy Sci. 47:993–996.
Otterby, D. E., H. A. Ramsey, and G. H. Wise. 1964b. Source of lipolytic enzymes in the abomasum of the calf. J. Dairy Sci. 47:997–999.
Palmer, T. 1995. Monomeric and oligomeric enzymes. Pages 77–79 in Understanding enzymes. Fourth ed. Prentice Hall/Ellis Horwood, London.
Pederson, H. E., and J. W. Sissons. 1984. Effect of antigenic soybean protein on the physiology and morphology of the gut in the preruminant calf. Can. J. Anim. Sci. 64 (Suppl.):183–184.
Pitas, R. E., and R. G. Jensen. 1970. Action of pregastric esterase on synthetic triglycerides containing butyric acid. J. Dairy Sci. 53:1083–1085.
Ramsey, H. A., G. H. Wise, and S. B. Tove. 1956. Esterolytic activity of certain alimentary and related tissues from cattle in different age groups. J. Dairy Sci. 39:1312–1322.
Ramsey, H. A., and J. W. Young. 1961a. Role of pregastric esterase in the abomasal hydrolysis of milk fat in the young calf. J. Dairy Sci. 44:2227–2231.
Ramsey, H. A., and J. W. Young. 1961b. Substrate specificity of pregastric esterase from the calf. J. Dairy Sci. 44:2304–2306.
Russell, R. W., E. V. Caruolo, and G. H. Wise. 1980. Effects of pregastric esterase on utilization of whole milk by preruminant calves. J. Dairy Sci. 63:1114–1122.
Tamate, H., A. D. McGilliard, N. L. Jacobson, and R. Getty. 1962. Effect of various dietaries on the anatomical development of the stomach in the calf. J. Dairy Sci. 45(3):408–420.
Toothill, J., S. Y. Thompson, and J. D. Edwards-Webb. 1976. Studies on lipid digestion in the preruminant calf. The source of lipolytic activity in the abomasum. Br. J. Nutr. 36:439–447.
Weigand, E., J. W. Young, and A. D. McGilliard. 1975. Volatile fatty acid metabolism by rumen mucosa from cattle fed hay or grain. J. Dairy Sci. 58:1294–1300.
Young, J. W., H. A. Ramsey, and G. H. Wise. 1960. Effects of age and diet on the secretion of pregastric esterase in calves. J. Dairy Sci. 43:1068–1075.

4.2 Effect of starch substitution in starter concentrate on ruminal pH and growth in young calves

Jakob Sehested, Mogens Vestergaard, Niels B. Kristensen, Søren K. Jensen
Faculty of Agricultural Sciences, University of Aarhus, DK-8830 Tjele, Denmark

4.2.1 Abstract

Calf starter concentrates are often grain-based. However, feeding diets with high starch content to fully developed ruminants induces low ruminal pH and even subacute ruminal acidosis. We hypothesized that: 1) a traditional barley-based starter will induce an acidic ruminal environment in the young calf; 2) it is possible to formulate a low-starch starter, which does not induce acidotic ruminal conditions, but still supports ruminal development and high growth rates. Two experiments were performed, each with 8 calves implanted with ruminal cannulas on d 7±1. Calves had free access to hay and water. Feed intake, weight gain and ruminal pH were recorded. In exp. 1 calves were allocated to four milk allowances (3.10, 4.84, 6.60, or 8.34 kg), and had free access to a traditional starter containing 50% barley (319 g starch/kg). Starter intakes above 20 g DM/d induced a daily ruminal pH minimum at pH 5.5 (limit for subacute acidosis) or lower for 5 to 13 h/d. Milk allowance did not influence the acidifying effect of the calf starter. In exp. 2 calves were fed 6.60 kg milk/d, and had free access to either the barley-based starter from wk 1 (CON) or to a low-starch starter (68 g starch/kg) from week 4 (ALT). Calves were weaned at wk 8 and sacrificed at wk 10. There were no treatment effects on ADG (802±35 g/d) or total solid feed DMI (78±4 kg). Intake of hay was higher both before and after wk 4 ($P<0.05$) and minimum ruminal pH was higher (6.14 vs. 5.57±0.09, $P < 0.01$) in ALT compared with CON calves. There were no differences in ruminal development at wk 10. The results question the use of calf starters with high contents of starch. The alternative low-starch starter supported non-acidotic ruminal environment, normal ruminal development and high growth rates in milk-fed calves.

4.2.2 Introduction

Early weaning of dairy calves is practiced for convenience and economic reasons. Specially formulated starter concentrates with high palatability and high contents of easily fermentable carbohydrates are used to stimulate adaptive changes in epithelia of the forestomachs, as volatile fatty acids (VFA) and especially butyrate are known to stimulate the development of ruminal papillae in young calves (Sander et al., 1959). However, the general awareness of the negative influence of subacute ruminal acidosis on health and production in both growing and dairy cattle (Nagaraja and Chengappa, 1998; Owens et al., 1998; Stone, 2004) has not translated into special precautions for protecting the juvenile rumen of the young calf against low ruminal pH. Ingestion of corn-based starter concentrates are followed by ruminal pH measurements of approximately 5.5 (Anderson et al., 1987) which is considered the borderline for subacute ruminal acidosis (Nordlund et al., 2004). The substitution of corn with barley in Northern Europe might even exaggerate the condition because of the increased ruminal degradation rate of barley starch compared with corn starch (Nocek and Tamminga, 1991). Our hypotheses were: 1) that a typical European calf starter with 50% steam rolled barley would induce ruminal fermentation in young calves characterized by a pH lower than usually recommended in cattle; and 2) that it is possible to formulate a low-starch calf starter, which do not induce acidotic ruminal conditions, but still supports ruminal development and

high growth rates. The objective of the study was to characterize the ruminal environment and mass, content, and morphometric measures of the gastrointestinal tract compartments as well as animal performance during the first weeks of life in Holstein calves.

4.2.3 Materials and Methods

Design, animals and feeding
Two experiments were performed, each with 8 Holstein calves implanted with ruminal cannulas on d 7±1.

Design of exp. 1: Calves were allocated to four milk allowances (3.10, 4.84, 6.60, or 8.34 kg), and had free access to a traditional starter (TRAD) containing 50% barley (319 g starch/kg) from week 1. Calves were sacrificed at 5½ wk of age.

Design of exp. 2: Calves were fed 4.74 kg milk/d in wk 1 to 2, 6.60 kg milk/d in wk 2 to 7 and 3.30 kg milk/d in wk 7 to 8. Calves had free access to either the barley-based starter (TRAD) from wk 1 or to a low-starch starter (ALT) (68 g starch/kg) from week 4. Calves were weaned at wk 8 and sacrificed at wk 10.
All calves had free access to water and artificially dried, fine grass hay (Dangrønt products A/S, Ringkøbing, Denmark). Skim milk-replacer (Friska Sød, DLG, Copenhagen, Denmark) and calf starter concentrates were allocated twice daily according to experimental design. The traditional calf starter was Grønkalv (DLG, Copenhagen, Denmark, composition (%): steam rolled barley, 50.0; soybean meal toasted, 17.4; linseed meal, 10.0; corn, 5.0; wheat, 4.3; sugar beet molasses, 4.0; limestone, 3.5; palm fat, 1.5; monocalcium phosphate, 0.5; salt, 0.4; vitamin premix, 0.2; propionic acid, 0.2. All ingredients except barley were pelleted and mixed into steam rolled barley). The alternative low-starch starter concentrate (ALT) was produced and pelleted at the Research Center Foulum's feed mill facility (Content, %: Grass pellets medium, 30; Soybean meal, 21; Sugar beet molasses, 20; Oat, grounded, 14; Sugar beet pulp pellets, 9.5; Veg. fat and Leci-E (vitamin E), 4; Minerals, type-1, 1; Salt and vitamins, 0.5).

Registrations and Samplings during Experiments
Registrations and analyses: Individual daily feed intake and weekly weight gain were recorded. Twelve or eight (exp. 1 and 2, respectively) ruminal fluid samples (every 2 h) were obtained weekly from the ventral ruminal sac of each calf using a suction strainer (Bar Diamond, Parma, ID). Ruminal fluid pH was measured immediately after sampling each calf (IQ 240; IQ Scientific Instruments Inc., Carlsbad, CA). Immediately after reading pH a sub sample of ruminal fluid was stabilized with 5% meta phosphoric acid and frozen at -20°C. Ruminal fluid VFA was analyzed by gas chromatography (Kristensen et al., 1996).

Slaughter, Tissue Sampling, and Scoring of Ruminal Papillae
The calves were euthanized by captive bolt stunning and exsanguination one to two days after the last sampling (5½ wk of age in exp. 1 and 10 wk of age in exp. 2). The gastrointestinal tract, liver, and kidneys were harvested immediately and viscera-free carcass weight was determined (including: head, hide, feet, and tail). The gastrointestinal tract was separated by strings and dissected into reticulorumen, omasum, abomasum, and small- and large intestine. The kidneys were dissected into organ and perirenal fat. Total weights and weights of contents and empty organs were measured and recorded. The reticulorumen was rinsed in tap water and examined for papillary aggregation, edema, and necrosis in the atrium and cranial part of the ventral ruminal sac. Using a ruler two operators individually and independently

measured the length of 5 randomly selected papillae at the floor of the atrium and cranial part of the ventral ruminal sac.

4.2.4 Results and discussion

Body Weight, Feed Intake, and Average Daily Gain (Exp. 1)
Weight at birth, final body weight, and age at slaughter were not different among treatments (Table 1). A treatment by wk interaction was observed for concentrate intake (Table 1) reflecting efficient substitution of milk with concentrate on Treatment 3.10. These effects of milk allowance on concentrate intake is in agreement with previous studies (Jasper and Weary, 2002; Brown et al., 2005; Von Keyserlingk et al., 2006).
A linear treatment by week interaction was observed for average daily gain reflecting lower daily gain with the two lowest milk allowances during the first two weeks and similar daily gain among all treatments in the last two wks of the study. Hay intake as a percentage of total concentrate + hay intake (wt/wt) was 5 to 10 ± 2% and not affected by treatment or wk.

Table 1. Birth weight, final weight, visceral free carcass weight, feed intake, ME intake, and ADG of Holstein calves fed four different milk allowances during wk 2 to 5 of age (Exp. 1)

	Treatment[1]							
Item	**3.10**	**4.84**	**6.60**	**8.34**	**SEM**[2]	**T**[3]	**W**[3]	**TxW**[3]
Birth weight, kg	42	45	42	45	1			
Age at slaughter, d	37.5	38.5	37.0	37.0	1			
Milk intake, g DM/d	403	589	788	958	6	***	***	***
Concentrate intake, g DM/d	756	520	179	287	93	*	***	**
Hay intake, g DM/d	32	21	13	19	13		**	
ME intake, MJ/d	19	19	18	23	1		***	**
ADG, g/d	678	679	654	794	88		**	
Ruminal pH	5.71	5.56	6.19	5.85	0.20		*	*
Average daily minimum ruminal pH	5.30	5.14	5.66	5.47	0.17			

[1]Treatments: kg milk-replacer divided into two equally sized portions fed at 0800 and 1500
[2]SEM = standard error of the mean
[3]Effect of treatment (T), week (W) and treatment by week (TxW); '*'=$P < 0.05$, '**'=$P < 0.01$, '***'=$P < 0.001$

Ruminal pH (Exp. 1)

Ruminal pH was more similar among treatments than expected (Table 1). A linear treatment by wk interaction ($P < 0.05$) for ruminal pH was observed reflecting that calves with high milk intake had higher ruminal pH during the first two wks and all treatments approaching the same level during the last two wks of the study. Two calves in wk 2 and one calf in wk 3 had a concentrate intake below 20 g DM/d and it appears that only these 3 observations contributes to the apparent difference among treatments in the first part of the study. The daily minimum ruminal pH was not affected by treatment or wk (5.14 to 5.66 ± 0.17 and 5.21 to 5.57 ± 0.15, respectively). Thus, there was no correlation between concentrate intake and severity of the ruminal pH depression with concentrate intakes above 20 g DM/d (Figure 1).

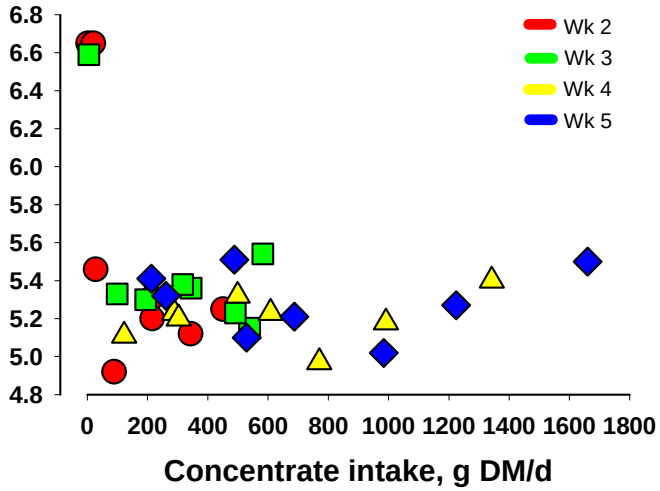


Figure 1: Observations of daily minimum ruminal pH in relation to concentrate intake (Exp. 1)

Body Weight, Feed Intake, and Average Daily Gain (Exp. 2)

There were no treatment effects on weight at birth (48 ± 1 kg) or average daily weight gain (802 ± 35 g/day) (Fig. 2). Concentrate intake increased rapidly after its introduction on both treatments, but at the highest rate on the low starch ALT concentrate treatment. Concentrate intake was similar between treatments 3 weeks after introduction of the ALT concentrate (Fig. 3). Total intake of solid feeds (concentrate + hay; 78 ± 4 kg) did not differ between treatments over the 10 weeks.

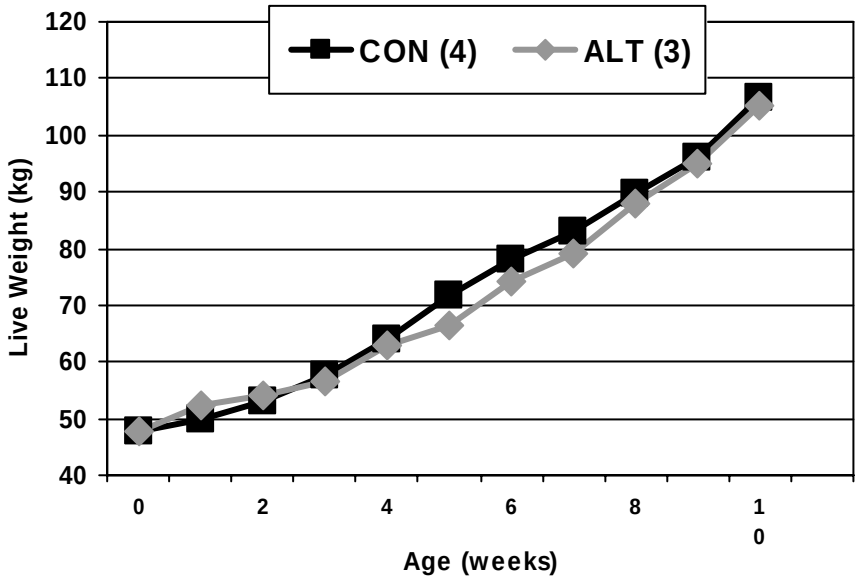


Figure 2: Average weight in relation to age and treatment (Exp. 2).

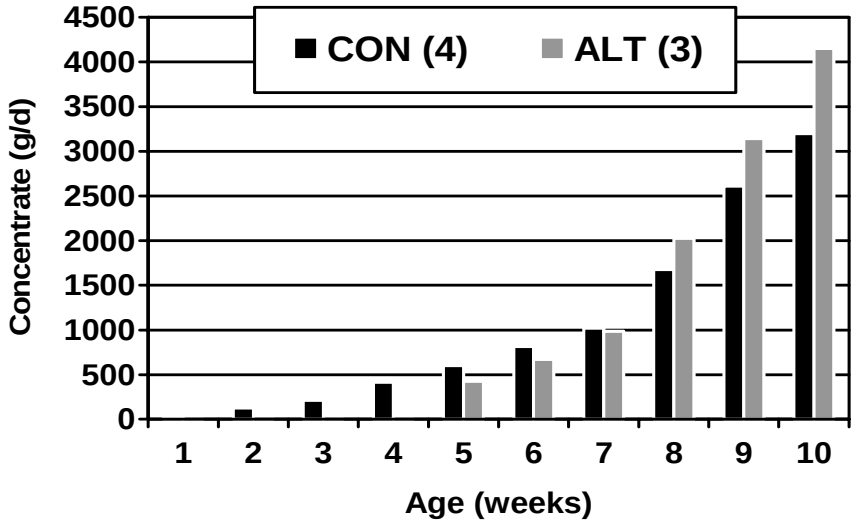


Figure 3: Average daily intake of concentrate in relation to age and treatment (Exp. 2).

Ruminal pH (Exp. 2)
Average ruminal pH was higher with ALT compared with TRAD (6.39 vs. 6.04 ± 0.09) and also the daily recorded minimum pH was highest with ALT (Fig. 4)

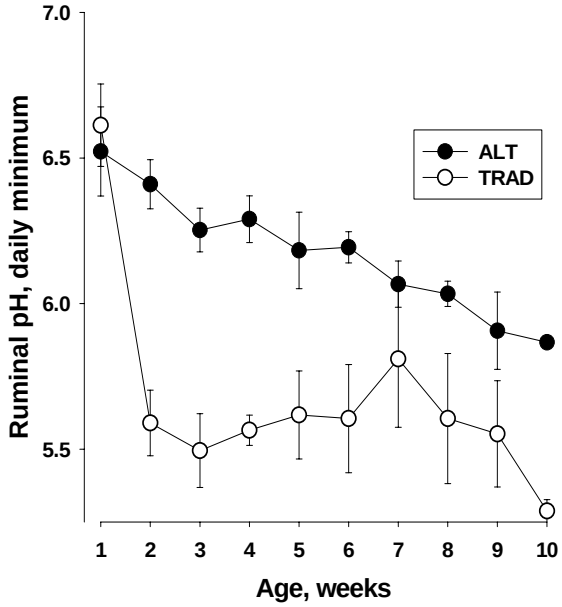


Figure 4: Observations of daily minimum ruminal pH in relation to age and treatment (Exp. 2)

Ruminal development at week 10 was not different between ALT and TRAD groups.

4.2.5 Conclusions

The traditional calf starter with 50% steam rolled barley induced a daily ruminal pH minimum at pH 5.5 (limit for subacute acidosis) or lower for 5 to 13 h/d. The alternative low-starch starter supported non-acidotic ruminal environment and normal ruminal development without negative effect on growth rates. The results question the use of calf starters with high contents of starch.

4.2.6 Literature

Anderson, K. L., T. G. Nagaraja, and J. L. Morrill. 1987. Ruminal metabolic development in calves weaned conventionally or early. J. Dairy Sci. 70:1000-1005.

Brown, E. G., M. J. Vandehaar, K. M. Daniels, J. S. Liesman, L. T. Chapin, D. H. Keisler, and M. S. Weber Nielsen. 2005. Effect of increasing energy and protein intake on body growth and carcass composition of heifer calves. J. Dairy Sci. 88:585-594.

Jasper, J., and D. M. Weary. 2002. Effects of ad libitum milk intake on dairy calves. J. Dairy Sci. 85:3054-3058.

Kristensen, N. B., A. Danfær, V. Tetens, and N. Agergaard. 1996. Portal recovery of intraruminally infused short-chain fatty acids in sheep. Acta Agric. Scand. Sect. A 46:26-38.

Nagaraja, T. G., and M. M. Chengappa. 1998. Liver abscesses in feedlot cattle: A review. J. Anim. Sci. 76:287-298.

Nocek, J. E., and S. Tamminga. 1991. Site of digestion of starch in the gastrontestinal tract of dairy cows and its effect on milk yield and composition. J. Dairy Sci. 74:3598-3629.

Nordlund, K. V., N. B. Cook, and G. R. Oetzel. 2004. Investigation strategies for laminitis problem herds. J. Dairy Sci. 87 (E. Suppl.):E27-E35.

Owens, F. N., D. S. Secrist, W. J. Hill, and D. R. Gill. 1998. Acidosis in cattle: A review. J. Anim. Sci. 76:275-286.

Sander, E. G., R. G. Warner, H. N. Harrison, and J. K. Loosli. 1959. The stimulatory effect of sodium butyrate and sodium propionate on the development of rumen mucosa in the young calf. J. Dairy Sci. 42:1600-1605.

Stone, W. C. 2004. Nutritional approaches to minimize subacute ruminal acidosis and laminitis in dairy cattle. J. Dairy Sci. 87 (E. Suppl.):E13-E26.

Von Keyserlingk, M. A. G., F. Wolf, M. Hötzel, and D. M. Weary. 2006. Effects of continuous versus periodic milk availability on behavior and performance of dairy calves. J. Dairy Sci. 89:2126-2131.

4.3 Datastyrte melkefôringsautomater for kalver. Oversikt over internasjonale forskningsresultater

Knut Egil Bøe(1) og Margit Bak Jensen(2)
1 Universitetet for miljø- og biovitenskap, Institutt for husdyr- og akvakulturvitenskap, 1432 Ås, Norge
2 Aarhus Universitet, Det Jordbrugsvidenskabelige Fakultet, Forskningscenter Foulum, 8830 Tjele, Danmark

4.3.1 Sammendrag

En rekke ulike modeller av datastyrte melkefôringsautomater er nå tilgjengelig på det norske markedet, og antagelig er opp mot 2000 slike solgt til norske bønder. Underlig nok er det gjort lite internasjonal forskning på slike melkefôringssystemer. Et høyt belegg av drikkestasjonen (stort antall kalver) medfører problemer med konkurranse. Både en liten daglig melkemengde og et høyt antall porsjoner øket den tiden kalvene okkuperte drikkestasjonen, noe som også medførte øket konkurranse om tilgang til drikkestasjonen. Derfor lykkes man best med datastyrte melkefôringsautomater ved å tildele kalvene en forholdsvis stor melkemengde i porsjoner a 1,5 – 2,0 liter og ved å holde antallet kalver i en gruppe med en drikkestasjon lavt (10 – 12 kalver).

4.3.2 Abstract

Several different types of computer controlled milk feeding systems are now marketed in Norway, and maybe as many as 2000 are sold to Norwegian dairy farmers. Using large groups of calves per feeder will entail problems with competition among the calves. Both a low daily milk allowance and a high number of portions per day increased the total occupation time of the feeder, which also increased the competition for access to the feeder. Hence, to be successful with computer controlled milk feeding for calves it is recommended to provide a high daily milk allowance in relatively large portions (1.5 – 2.0 litres) and to keep the number of calves per feeder low (10 – 12 calves).

4.3.3 Innledning

Datastyrte automater for kraftfôr ble introdusert for melkeku på 1970-tallet og finnes nå i de fleste moderne løsdriftsfjøs. Tilsvarende system for drektige purker ble utviklet og introdusert i Nederland i 1982. Utvikling av datastyrte melkefôringsautomater for kalver ble gjort i Bayern i Tyskland, og forsøk med en prototype (Förster technik) beskrives av den tyske forskeren Pirkelmann allerede i 1981 (Pirkelmann, 1981 a,b). Fordelene med datastyrt melkefôring oppgis å være mulighet for individuell tildeling, reduserte fôrkostnader og redusert arbeid. Både DeLaval og Westfalia forhandlet etter hvert melkefôringsautomaten fra Förster technik, men med sitt eget styrings- og fôrregime. Et av de første forsøkene utenfor Tyskland ble utført ved den gang Norges landbrukshøgskole fra 1990 (Bøe og Havrevoll, 1993). Senere er det kommet til flere tilsvarende produkter på det nordiske markedet fra ulike produsenter:

- DeLaval/Förster technik/Biocontrol (modellene CF100, CF200 og CF300 samt CF150)
- Holm og Laue (modell Joker Calf feeder).
- Urban (modellene U20 og U40)
- Westfalia/Förster technik (modellene PremiumBoy og EcoBoy)

Selv om de norske firmaene ikke oppgir salgstall, er det grunn til anta at antall solgte enheter ligger nærmere 2000 (i alle fall mer enn 1000) og at DeLaval er den som er klart størst på det norske markedet. Noe av forskjellen mellom de forskjellige typene av datastyrte melkefôringsautomater ligger i styringen av fôrregimet. DeLaval satser på sitt "kvalifiseringssystem" der kalvene får tilgang til en ny porsjon etter en gitt tid. Eksempelvis vil en dagsrasjon på 6 liter fordeles ut med 12 halvliterporsjoner, det vil si at kalven får tilgang på en ny halv liter hver andre time. Holm og Laue anvender et annet prinsipp der døgnet deles i to 12-timers perioder og det defineres et minimum antall porsjoner innenfor hver 12-timers periode.

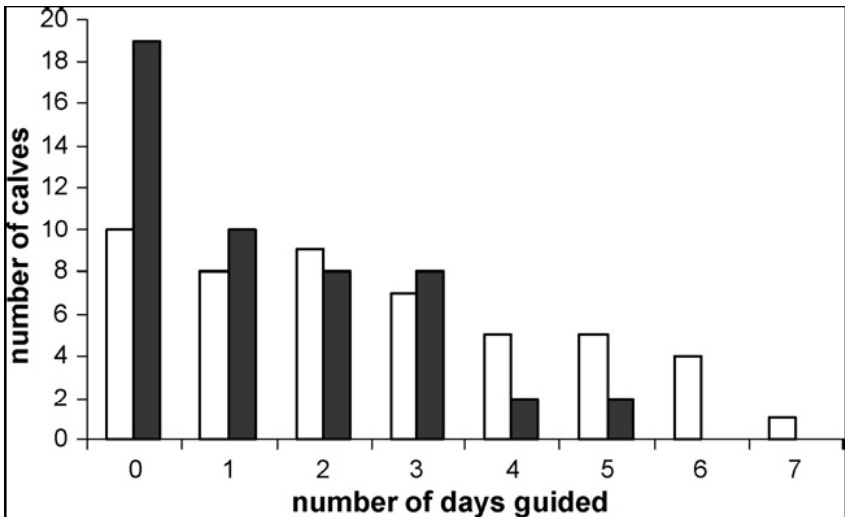
For å kunne lykkes med datastyrte melkefôringsautomater er det nødvendig å finne svar på en rekke grunnleggende spørsmål: (a) Introduksjon av nye kalver, (b) antall kalver pr. melkefôringsautomat, (c) antall porsjoner/utfôringer pr. dag og (d) metode for avvenning. Underlig nok er det gjort lite internasjonal forskning på disse problemstillingene. Formålet med dette foredraget er å gjennomgå de forsøk som dog er gjennomført i de senere år, spesielt i Danmark i perioden 2001 - 2006.

4.3.4 Resultatat og diskusjon

Introduksjon av kalver

Når det benyttes datastyrte melkefôringsautomater vil det gjerne være dynamiske grupper der nye kalver introduseres med jevne mellomrom. Et viktig spørsmål ved innsett av nye kalver er ved hvilken alder de bør introduseres.

I et forsøk i Danmark (Jensen, 2006b) ble kalver i par, henholdsvis 6 og 14 dager gamle, introdusert til en dynamisk gruppe av kalver som ble tildelt melk fra en datastyrt melkefôringsautomat. Kalver som konsumerte mindre enn halvparten av sin tildelte rasjon for to påfølgende 12-timers perioder ble hjulpet inn i fôringsautomaten av en røkter. De kalvene som ble introdusert ved 6 dagers alder måtte assisteres gjennomsnittlig to dager mens kalver introdusert ved 14 dagers alder bare måtte assisteres en dag i løpet av den første uken (se figur 1). Kalver introdusert ved 6 dagers alder hadde også et lavere inntak av melk og brukte kortere tid på ubelønnede besøk.



Figur 1. Antall kalver som ble hjulpet inn i melkefôringsautomaten de første 7 dagene etter innsett for kalver introdusert ved 6(hvite søyler) og 14 (svarte søyler) dagers alder (etter Jensen, 2006).

Levendevekten var dog ikke signifikant forskjell ved 40 dagers alder for kalver introdusert ved 6 og 14 dagers alder.

I et tilsvarende forsøk fant Rasmussen et al. (2006) ingen klare forskjeller i bruk av melkefôringsautomaten når kalvene ble introdusert ved henholdsvis 6 og 14 dagers alder, men de tidlig introduserte kalvene slikket og snuste mindre, endret liggestilling oftere og lå lenger vekk fra andre kalver, noe som forfatterne tolker som at disse kalvene var mer urolige og dårligere integrert i gruppen.

Oppsummerer vi resultatene, ser det ut til at kalver introdusert ved 6 dagers alder har et lavere melkeinntak, har større problemer med å få tilgang til melkefôringsautomaten og trenger mer assistanse fra røkteren.

Antall kalver pr. automat

Pirkelmann (1981a) hevder, delvis på grunnlag av erfaringer, at en melkefôringsautomat kan betjene 40 kalver. I en senere artikkel (Pirkelmann og Wendling, 1988) presenteres data som tolkes til å vise at en stasjon kan betjene 30 kalver. Videre hevder Förster technik i sine brosjyrer at deres melkefôringsautomater kan betjene opp til 30 kalver og DeLaval skriver i sine informasjonsblad at en automat kan betjene 25 – 30 kalver. Ingen viser imidlertid til data som de baserer sine anbefalinger på.

I et forsøk med 26 kalver pr. fôrstasjon (Morita et al., 1999) ble det funnet at kalvene faktisk brukte mer tid på vente på å få tilgang til melkefôringsautomaten enn de brukte på å stå inne i selve automaten. På bakgrunn av dette trekker forfatterne den slutning at system må forbedres slik at ventetiden reduseres. I et kontrollert forsøk med totalt 192 kalver ble disse fordelt til grupper med 12 og 24 kalver pr. melkefôringsautomat (Jensen, 2004).

Tabell 1. Effekt av antall kalver pr. melkefôringsautomat (Jensen, 2004).

	Antall kalver pr. automat		P
	12	24	
Alle besøk (min/24 t)	36,50 ± 1,33	30,43 ± 1,34	< 0,01
Belønnede besøk (min/24 t)	22,84 ± 0,73	18,51 ± 0,71	< 0,001
Drikker melk (min/24 t)	18,40 ± 0,75	13,03 ± 0,79	< 0,001
Etter melkeinntak (min/24 t)	3,58 ± 0,46	5,05 ± 0,69	IS
Ubelønnede besøk (min/24 t)	6,67 ± 1,12	7,96 ± 1,53	IS
Drikkehastighet (l/min)	0,301 ± 0,017	0,397 ± 0,022	< 0,01
Okkupering av automaten (min/24 t)	41,25 ± 3,38	26,70 ± 3,46	< 0,01
Okkupering av automat alene (min/24 t)	35,61 ± 3,61	12,62 ± 4,85	< 0,01
Venter på tilgang (min/24 t)	5,70 ± 1,92	21,36 ± 4,97	< 0,01
Forsøker å gå inn i okkupert stasjon	1,82 ± 0,42	4,05 ± 0,78	= 0,02
Fortrenger kalv fra okkupert stasjon	1,40 ± 0,28	2,45 ±0,36	= 0,03

Resultatene viste at lengden av belønnede besøk og tid brukt til å drikke melk var signifikant kortere for grupper med 24 kalver, slik at drikkehastigheten økte fra 0,301 til 0,397 liter pr. minutt for gruppene med henholdsvis 12 og 24 individer (tabell 1). Antall av belønnede besøk var litt høyere (6,45 vs. 5,86 pr. døgn) og antall ubelønnede besøk var noe lavere (6,67 vs. 7,96) pr. døgn i gruppene med henholdsvis 12 og 24 individer, men denne forskjellen var ikke signifikant. Derimot var det signifikant lenger ventetid for å komme til melkefôrings-automaten ved 24 kalver i gruppen og likeledes var forsøk på å få tilgang til og fortrenge en kalv fra melkefôringsautomaten klart høyere (tabell 1). Kalver i store grupper ble forstyrret i 50 % av den tiden de var inne i drikkestasjonen, mens kalvene i de små gruppene bare ble forstyrret i 10 % av tiden. For suging på andre kalver var det var store individuelle forskjeller. 49 % av kalvene ble ikke observert å utføre suging på andre kalver, mens 25 % sugde på andre kalver > 3 minutter pr. døgn. Det var imidlertid ingen effekt av antall individer i gruppen på disse parametrene.

En gruppestørrelse på maksimalt 10 kalver vil, ut fra et lavere nivå av konkurranse, også medføre en mindre risiko for luftveisinfeksjoner (Svensson et al., 2003). Svensson og Liberg (2006) fant likeledes at kalver i gruppe på 8 hadde 40 % lavere risiko for luftveislidelser og 40 gram høyere daglig tilvekst enn kalver i gruppe på 16 dyr.

Melkemengde

Forsøkene har også vist at kalvene besøker drikkestasjonen mange ganger forgjeves og at melkemengden betyr mye for disse ubelønnede besøkene (Jensen og Holm, 2003; Jensen, 2006a). Kalver på lav melkemengde (5 liter/dag) har i gjennomsnitt 35 ubelønnede besøk i drikkestasjonen pr. dag sammenlignet med 15 ubelønnede besøk pr dag for kalver tildelt en stor melkemengde (8 liter/dag). Det vil si at kalver som ble tildelt en liten melkemengde flere ganger gikk inn i drikkestasjonen for å se om de kunne få tilgang på melk. Videre betyr det at

kalvene tildelt en liten melkemengde okkuperte drikkestasjonen 51 minutter pr. dag mot 42 minutter for kalver med høy daglig melkemengde. Av denne tiden var 30 minutter ubelønnede besøk for kalver med liten daglig melkemengde mot 14 minutter for kalver med stor daglig melkemengde (Jensen, 2006a). Mange ubelønnede besøk i drikkestasjonen er uheldig fordi drikkestasjonen blokkeres for kalver som har tilgang til melk, spesielt ved høyt belegg.

Antall utfôringer pr. dag

En av de fordeler som oppgis for datastyrte melkefôringsautomater er at dagsrasjonen av melk kan fordeles på mange utfôringer. Mens noen modeller tillater å styre antall daglige utfôringer (bl.a. Joker fra Holm & Laue) benytter DeLaval et system med såkalt kvalifisering, dog med mulighet for å definere et maksimalt antall porsjoner pr. dag. En økning av antall daglige porsjoner vil høyst sannsynlig også påvirke melkefôringsautomatens kapasitet.

I en dansk studie (Jensen, 2004) fikk kalvene samme daglige melkemengde, men fordelt på henholdsvis 4 og 8 porsjoner daglig (tabell 2). Ikke uventet gikk antall besøk, både belønnede og til dels også ubelønnede besøk ned når antall porsjoner ble redusert. Videre ble tiden kalvene stod inne i melkefôringsautomaten (okkupasjonstiden) og ventetid på å få tilgang til melkefôringsautomaten redusert når antall porsjoner ble redusert. Uansett hvor mye melk kalven får, så stimuleres sugemotivasjonen ved hver tildeling av melk. Årsaken til at kalvene okkuperer drikkestasjonen i lengre tid når de får samme melkemengde fordelt på 8 porsoner fremfor 4, er at de skal tilfredsstille sugemotivasjonen ved hver melkeporsjon. Få og store porsjoner medfører sannsynligvis også mindre risiko for at kalvene suger på hverandre, dels fordi sugemotivasjoen utløses færre ganger og dels fordi kalven rekker å få tilfredsstilt sitt sugebehov når den drikker.

Tabell 2. Effekt av antall utfôringer pr. dag på kalvenes bruk av melkefôringsautomaten (etter Jensen, 2004).

	Antall utfôringer pr. døgn		P
	4	8	
Alle besøk (min/24 t)	30,27 ± 1,22	36,69 ± 1,35	< 0,001
Belønnede besøk (min/24 t)	18,28 ± 0,66	23,10 ± 0,73	< 0,0001
Drikker melk (min/24 t)	15,03 ± 0,64	16,18 ± 0,66	IS
Etter melkeinntak (min/24 t)	2,86 ± 0,39	6,00 ± 0,57	< 0,001
Ubelønnede besøk (min/24 t)	7,00 ± 1,09	7,62 ± 1,12	IS
Drikkehastighet (l/min)	0,372 ± 0,016	0,326 ± 0,016	< 0,01
Belønnede besøk (antall/24 t)	5,02 ± 0,31	7,45 ± 0,38	< 0,001
Ubelønnede besøk (antall/24 t)	7,00 ± 1,09	7,62± 1,12	IS
Okkupering av automaten (min/24 t)	41,25 ± 3,38	26,70 ± 3,46	< 0,01
Okkupering av automat uforstyrret (min/24 t)	35,61 ± 3,61	12,62 ± 4,85	< 0,01
Venter på tilgang (min/24 t)	5,70 ± 1,92	21,36 ± 4,97	< 0,01

I en annen studie utført nylig i Danmark (Rasmussen et al., 2006) med kalver fôret med 8 og 4 porsjoner pr. dag, viste det seg at kalver som ble fôret med færrest daglige utfôringer stod kortere i melkefôringsautomaten, suget mindre på gummispenen uten tilgang på melk og holdt seg mindre i området rundt melkefôringsautomaten. I denne gruppen var det interessant nok også en høyere frekvens av lek.

Avvenningsmetode
Det er selvfølgelig mulig å avvenne kalver brått, men oftest avvennes kalvene gradvis ved å redusere størrelsen på hver porsjon. En annen metode er å redusere antall porsjoner pr. dag, noe som kan føre til en kortere okkupasjonstid av melkefôringsautomaten og muligens stimulere kalvenes opptak av kraftfôr.

Jensen (2006b) gjennomførte nylig et forsøk med 96 kalver ble tildelt en høy dagsrasjon (8 liter/dag) og lav dagsrasjon (4,8 liter/dag) og kalvene ble avvent gradvis fra dag 51 til dag 68 ved å enten redusere antall daglige utfôringer eller ved å redusere størrelsen på hver porsjon (tabell 3). Etter en uke, hvor melkemengden var trappet ned til det halve, var det imidlertid ingen vesentlige virkninger av verken melkemengde eller av antall porsjoner på hvor lang tid kalvene okkuperte drikkestasjonen. Men 60 % av tiden i drikkestasjonen var ubelønnede besøk. Dette illustrerer at kalvene under avvenning var mer sultne og at det er sult som først og fremst bestemmer antall ubelønnede besøk.

Tabell 3. Effekt av avvenningsmetode på bruk av melkefôringsautomat, fôropptak og tilvekst (Jensen, 2006b).

	Avvenningsmetode		P
	Redusert porsjonsstørrelse	Redusert antall porsjoner	
Dag 61 - 63			
- Alle besøk (min/24 t)	30,36 ± 3,02	31,48 ± 3,07	IS
- Belønnede besøk (min/24 t)	11,77 ± 1,12	10,28 ± 1,04	0,06
- Drikker melk (min/24 t)	8,47 ± 0,89	7,40 ± 0,84	0,04
- Etter melkeinntak (min/24 t)	3,22 ± 0,46	2,88 ± 0,44	0,06
- Ubelønnede besøk (min/24 t)	15,65 ± 2,20	20,48 ± 2,55	0,03
Antall belønnede besøk	4,09 ± 0,16	2,45 ± 0,13	< 0,001
Opptak av kraftfôr dag 61-63 (kg/dag)	1523 ± 117	1698 ± 117	IS
Daglig tilvekst dag 55-68 (g/dag)	953 ± 64	1063 ± 64	IS

4.3.5 Litteratur

Bøe, K.E., Havrevoll, Ø., 1993. Cold housing and computer-controlled milk feeding for dairy calves. Anim. Prod., 57: 183-191.

Jensen, M.B., Holm, L., 2003. The effect of milk flow rate and milk allowance on feeding related behaviour in dairy calves fed by computer controlled milk feeders. Appl. Anim. Behav. Sci., 82: 87-100.

Jensen, M.B., 2004. Computer-controlled milk feeding of dairy calves: the effect of number of calves per feeder and number of milk portions on use of feeder and social behaviour. J. Dairy Sci., 87: 3428-3438.

Jensen, M.B., 2006a. Computer-controlled milk feeding of group-housed calves: the effect of milk allowance and weaning type. J. Dairy Sci., 89: 201-206.

Jensen, M.B., 2006b. Age at introduction to the group affects dairy calves' use of a computer-controlled milk feeder. Appl. Anim. Behav. Sci., in press, available online.

Morita, S., Sugita, S., Yamamoto, M., Hoshiba, S., Uemura, T., 1999. Behavioral investigation of group rearing calves in automatic milk replacer feeding system. Anim. Sci. J., 70: 542-546.

Pirkelmann, H., 1981a. Tränkedosierautomaten für die Kälberhaltung. Landtechnik 7/8: 368 – 372.

Pirkelmann, H., 1981b. Tränkedosierautomaten fûr Aufzuchtkälber. Der Tierzüchter 9: 393 – 396.

Pirkelmann, H, og Wendling, F., 1988. Micro-processor based feeding and controlling of calves. Proceedings of the *Third international livestock environment symposium*, Toronto, Canada, 25-27 April 1988: 248-253.

Rasmussen, L., Jensen, M.B., Jeppesen, L.L., 2006. The effect of age at introduction and number of milk-portions on the behaviour of group housed dairy calves fed by a computer controlled milk feeder. Appl. Anim. Behav. Sci., 100: 153-163.

Svensson, C. og Liberg, P. 2006. The effect of group size on health and growth rate of Swedish dairy calves in pens with automatic milk feeders. Prev. Vet. Med., 73, 43-53.

Svensson, C., Lundborg, K., Emanuelson, U., Olsson, S.O., 2003. Morbidity in Swedish dairy calves from birth to 90 days of age and individual calf-level risk factors for infectious diseases. Prev. Vet. Med. 58: 179-197.

5 Calf housing

5.1 Opstaldningsmuligheder for kalve

Bygningskonsulent, Cand. agro. Inger Dalgaard
Dansk Landbrugsrådgivning, Landscentret, Dansk Kvæg. Udkærsvej 15, Skejby, 8200 Århus N., Danmark.

5.1.1 Abstract

To be a high yielding dairy cow imply raising in a good and healthy way, in particular a good start of lift. Housing systems that give calves and staff optimal conditions are needed. Calves must always be moved into totally clean pens/huts including clean bowls etc. to avoid getting infections from the calves that just moved out. The pen/hut must provide the calves with dry, clean and comfortable bedding. Calves can stand low temperature, including frost, as long as they have a dry area without draught for resting. Good ventilation without draught is necessary. The calves must have access to fresh water, concentrates and hay all the time. The calves must be housed individually in at least two weeks from birth. To ensure health and protect the calves against infection and ensure social needs, the calves must be housed groupwise. The groups must be homogenous and not include more than 6-8 calves per group. Age differences between calves in the same group, should not exceed two weeks, less is preferable. The number of calves born in a period directly influences the optimal group size.. The daily work in the calf house must be easy and fast to do, with a minimum of hard physical work. That leaves more time and energy to observe the calves. That also means that housing calves is very much a question of making good solutions and good working routines for the daily work in the calf house. To make that work, the calf house and the working routines have to be developed together.

5.1.2 Sammendrag

Forudsætningen for at blive en højtydende malkeko er en god og sund opvækst, og ikke mindst en god start på livet. Det er således nødvendigt med staldsystemer til kalve, der har optimale forhold for både kalve og kalvepasser. Kalvene skal altid indsættes i helt rene bokse/hytter med rent inventar for at undgå smitte fra de foregående kalve. Boksen/hytten skal give kalven et tørt, rent og blødt leje. Kalve kan tåle lave temperaturer også frost, så længe de har et tørt og trækfrit leje. God ventilation uden træk er nødvendig. Nyfødte kalve skal opstaldes individuelt i mindst 2 uger. Maksimum 6-8 kalve pr. hold, forudsat holdene er homogene. Aldersforskellen på kalve i samme hold bør være så lille som mulig, maks. 2 uger, helst mindre. Den optimale holdstørrelse varierer derfor med antallet af kalve der fødes i perioden. Kalvene skal indsættes holdvis frem for kontinuerligt for at sikre kalvenes sundhed og tilgodese deres sociale behov. Det daglige arbejde i kalvestalden skal være let, og kræve mindst muligt fysisk arbejde. Derved bliver der mere tid og energi til opsyn med kalvene. Det nødvendigt at designe stalden og arbejdsrutinerne samtidig, for at opnå de bedste forhold for kalvene og samtidig optimere arbejdsopgaver og arbejdsmiljø. Der er mange forskellige måder at opstalde kalve på. Det kan være vanskeligt at opfylde alle krav. I dette foredrag vises forskellige løsninger.

5.1.3 Resultat og diskution

Fremtidens køer kræver høj standard i kalvestalden
Forudsætningen for at blive en højtydende malkeko er en god og sund opvækst, og ikke mindst en god start på livet. Derfor skal kalve altid indsættes i helt rene bokse/hytter med rene skåle etc. for at undgå smitte fra de foregående kalve. Boksen/hytten skal give kalven et tørt, rent og blødt leje. Kalve kan tåle lave temperaturer, også frostvejr, så længe de har et tørt og trækfrit leje. God ventilation uden træk er nødvendig. Kalve skal hele døgnet have adgang til rent vand, kalveblanding og hø.

Kalvens krav:
- **Ren boks/hytte og skåle**
- **Tørt, rent og blødt leje**
- **God ventilation uden træk**
- **Adgang til rent vand, kalveblanding og hø**

Fremtidens mælkeproducenter kræver et godt arbejdsmiljø
Det daglige arbejde i kalvestalden skal være let og hurtigt, og kræve mindst muligt fysisk arbejde. Derved bliver der mere tid og overskud til opsyn med kalvene.

For at opnå de bedste forhold for kalvene og samtidig optimere arbejdsopgaver og arbejdsmiljø er det nødvendigt at designe stalden og arbejdsrutinerne samtidig.

- **Kalvestald og arbejdsrutiner skal designes samtidig**

Figur 1 Store enkeltbokse placeret langs staldens yderside, hvor et stikspær giver overdækning. Bemærk pladen over boksenes bagerste halvdel, som skaber to klimazoner i boksene.

Rationelle arbejdsrutiner

Flytte kalve systematisk

Det er en fordel at sætte flytning af kalve i system. For eksempel således: På en fast ugedag flyttes kalvene og bokse/hytter muges ud og vaskes. Derefter skal de stå tomme og tørre ud i mindst 3 dage - helst en uge. Systemet kræver at der er nogle ekstra bokse, men sikrer også at der altid rene bokse/hytter til nyfødte kalve, - og det kommer aldrig som en overraskelse, at der skal muges kalvebokse.

Central placering
Kalvene skal placeres et centralt sted, hvor Kalvepasseren naturligt kommer forbi mange gange om dagen, og dermed ser til kalvene.

Elektrisk lys

Det skal være let at se til alle kalve, også når det er mørkt, både i bokse og hytter, derfor skal der installeres tilstrækkeligt elektrisk lys. En lommelygte eller pandelampe er sjældent nok.

Mælkefodring

Den daglige tildeling af mælk skal være let arbejde: Alt mælken blandes i én portion i en mikservogn, og køres derefter ud til kalvene. Alternativt kan mælkefodringsautomater opstilles, men gå aldrig på kompromis med holdstørrelse og hygiejnen.

Mælketilberedning

Der bør være et mælkerum til tilberedning af mælkeerstatning. Der skal være en stor vask og et tørrestativ til vask af skåle/pattespande. Der skal være plads til mikservogn, opbevaring af mælkepulver, et medicinskab, en fryser til opbevaring af frossen råmælk samt en skrivepult.

Drikkevand

Den letteste måde at sikre kalvenes forsyning af rent drikkevand i fællesbokse/-hytter, er at installere drikkekopper/-kar. Husk at frostsikre alle vandinstallationer!

Strøning

Ved at strø med en maskine/strømaskine spares både tid og kræfter.

Udmugning

Udmugning skal ske med maskiner. Derfor skal der være plads til at maskinerne kan komme ind og manøvrere rundt i stalden/boksene/hytterne.

Vask

Det er ikke et særligt attraktivt job at vaske kalvebokse/-hytter, men med en stor vandslange (evt. med højtryk) og fald til et stort afløb i gulvet er det lidt lettere. Det er som regel en fordel at sætte hele boksen/hytten i blød en times tid før det skylles rent.

Figur 2 Det er en stor arbejdslettelse at strø med maskine; det sparer meget tid og det er fysisk hårdt at strø manuelt

Rationelle arbejdsrutiner kræver:

- **At der flyttes kalve systematisk**
- **Central placering og godt lys i bokse/hytter som sikrer god overvågning**
- **Gode, enkle og effektive mælkefodringsrutiner**
- **Gode faciliteter til vask af skåle/pattespande, mælkevogn etc.**
- **At der er installeret drikkekopper/-kar i fællesbokse/-hytter**
- **At der strøes med maskine**
- **At der muges ud med maskiner**
- **At der er etableret afløb og vand til vask af bokse og/eller vaskeplads til hytter**

Kontinuerlig eller holdvis indsættelse af kalve

Kalvene skal samles og indsættes holdvis frem for kontinuerligt. Det forbedre kalvenes sundhed og tilgodeser deres sociale behov.

Figur 3 Delvis åben og uisoleret fælleshytte til to grupper af 5 kalve

Kontinuerlig indsættelse af kalve medfører en lavere daglig tilvækst og en højere frekvens af både diarré og luftvejslidelser sammenlignet med kalve, der bliver indsat i hold. Dette skyldes en øget smittespredning og en lavere grad af hygiejne ved kontinuerlig drift. Ved kontinuerlig indsættelse af kalve i fællesboksen skal der dannes et nyt hierarki, hver gang en ny kalv indsættes. Det giver meget uro i flokken. Hver ny kalv der indsættes bidrager i øvrigt med smitte, ved kontinuerlig indsættelse ophobes smitten i kalveholdet.

Kalve skal indsættes holdvis for at styrke deres sundhed og beskytte dem mod smitte. Fordele og ulemper ved kontinuerlig og holdvisindsættelse fremgår af tabel 1.

Tabel 1: Fordele (+) og ulemper (-) ved kontinuerlig og holdvis indsættelse af kalve

Kontinuerlig indsættelse		**Holdvis indsættelse**	
+	Der er behov for færre bokse end ved holddrift	-	Der er behov for flere bokse til kalvene
-	Boksene renses sjældnere, derved er smittetrykket højere	+	Boksene muges ud og vaskes som regel mellem hvert hold, derved reduceres smittetrykket væsentligt
-	Høj risiko for overførsel af smitte fra ældre kalve i boksen	+	Ingen risiko for overførsel af smitte fra tidligere kalve i boksen
-	Typisk store grupper af kalve, medfører højt smittetryk	+	Typisk små grupper af kalve, medfører lavt smittetryk
-	Ikke homogene, hold	+	Homogene, små hold
-	Hierarki skal genetableres hver gang der indsættes eller afgår en kalv fra holdet	+	Hierarki etableres én gang og forstyrres ikke efterfølgende

Nyfødte kalve skal opstaldes individuelt i mindst 2 uger. Der bør Maksimalt være 6-8 kalve pr. hold, forudsat holdene er homogene. Aldersforskellen på kalve i samme hold bør være så lille som mulig, maks. 2 uger, helst mindre. Den optimale holdstørrelse varierer derfor med antallet af kalve der fødes i perioden.

Opstaldning af kalve

- **Individuel opstaldning i mindst 2 uger**
- **Homogene grupper på maksimum 6-8 kalve**
- **Maksimum 2 ugers aldersforskel på kalve i samme hold**

Figur 4 Fast bund under fælleshytter gør pasning af kalve i hytter lige så let som pasning af kalve i stald

10 tips til gode kalvestalde:

1. **Rent, tørt og blødt leje**
2. **Stort luftskifte – trækfrit leje**
3. **Mindst 2 uger i enkeltbokse/hytter**
4. **Holddrift, maksimum 6-8 kalve pr. boks**
5. **Plads til at tilberede mælk og vaske skåle, tæt ved kalvene**
6. **Lavt smittetryk; adskilte gødnings- og foderveje, sektionering**
7. **Bokse kan renses uafhængigt af hinanden**
8. **Rationelle arbejdsrutiner – "let at ..."**
9. **Godt lys**
10. **Central placering – tilsyn**

5.1.4 Læs mere her:

www.danskeanbefalinger.dk
www.farmtest.dk
F.eks. FarmTest nr. 18: "Kalvestalde kontra kalvehytter"
FarmTest nr. 24: "Enkelt- og fælleskalvehytter"
FarmTest nr. 37: "Starterstalde til slagtekalve"
FarmTest nr. 40: "Konceptstald til kalve"
Pjece: "Fællesopstaldning af kalve, økologi". Dansk Kvæg, 2005. Kan købes i netbutikken: www.landscentret.dk/netbutik

5.2 Social behaviour of group housed calves -the effect of social and environmental factors

Gry Færevik, Inger Lise Andersen, Knut Egil Bøe,
Norwegian University of Life Science, Ås, Norway
Margit Bak Jensen
Danish Institute of Agricultural Sciences, Foulum, Denmark

5.2.1 Abstract

Results from two different studies show that not only social factors like group size and group composition, but also environmental factors like housing design will influence the social behaviour of calves. The first experiment show that an increased group size results in a higher activity level, fewer displacements from the feed barrier, more time spent resting and feeding in close proximity to other calves, and more positive social interactions between familiar calves after regrouping. A low level of aggression and rapid establishment of new social bonds imply that regrouping of calves after weaning is acceptable from an animal welfare point of view. However, social bonds should be taken into account. The second experiment investigated how calves resting pattern and social behaviour are influenced by the size of the lying area. It was found that the smallest lying space provided in the experiment (0.75 m^2 per calf for 100 kg calves and 1.00 m^2 per calf for 150 kg calves) was inadequate to allow synchronous resting, prevented the calves from lying in a recumbent posture with the legs stretched out, and forced the calves to rest in close proximity to others. The results underline the importance of adequate lying space even for animals such as calves that engage in few aggressive conflicts. To avoid jeopardizing the welfare of the calves in terms of satisfying their need to rest, we would thus not recommend the smallest lying space used in the present study.

5.2.2 Sammendrag

Resultater fra to ulike studier viser at både sosiale faktorer og oppstallingsforhold påvirker sosial atferd hos kalver oppstallet i gruppe. Det første forsøket viser at økt gruppestørrelse gir høyere aktivitetsnivå, færre fortrengninger fra fôrhekken, flere tilfeller der kalvene ligger og spiser tett ved en annen kalv, samt flere positive sosiale interaksjonen mellom kjente kalver etter regruppering. Et generelt lavt aggresjonsnivå og hurtig etablering av nye sosiale relasjoner tilsier at regruppering av kalver etter avvenning er akseptabelt med tanke på dyrenes velferd. Det bør imidlertid tas hensyn til sosiale bånd når nye grupper skal dannes. Det andre forsøket undersøkte hvordan kalvens atferd påvirkes av størrelsen på liggearealet. Det minste arealet som ble benyttet i forsøket (0.75 m^2 per kalv for kalver på omkring 100 kg og 1.00 m^2 per kalv for kalver på omkring 150 kg) viste seg å være for lite til at kalvene kunne ligge samtidig, hindret kalvene å ligge på siden med bena strukket ut, og medførte at kalvene måtte ligge tettere sammen enn hva som var tilfelle når de hadde mer plass tilgjengelig. Resultatene viser nødvendigheten av tilstrekkelig størrelse på liggearealet til kalv selv om aggressive interaksjonen sjelden forekommer. Det minste liggearealet benyttet i dette forsøket kan ikke sies å tilfredsstille krav til god dyrevelferd.

5.2.3 Introduction

In order to satisfy calves' motivation for social contact, group housing of calves older than eight weeks is now compulsory in the European Union (Council Directive 97/2/EEC). Compared to housing in small individual pens, group housing gives the calves' an opportunity to perform normal social behaviour as well as play behaviour (Jensen et al., 1998). For these reasons, group housing is considered to improve calf welfare. However, competition within the group and the common practice of regrouping (transfer of animals between groups or introduction of new animals into an established group) may cause aggression, social stress and disruption of circadian rhythms in cattle (Bøe and Færevik, 2003). The aim of the first experiment was to investigate how group size and familiarity influence calves' activity and social interactions after regrouping. The aim of the second experiment was to investigate how the size of the lying area influence calves resting and social behaviour.

5.2.4 Methods

Experiment 1
A total of 84 male and female, Norwegian Red Cattle (NRF) calves, were divided into three groups of 4, 8 or 16 individuals after weaning at the age of 8 weeks. Half of the calves in each group were unfamiliar to each other (housed in visually separated group pens before weaning and regrouping) whereas the other half was familiar (housed in the same group pen before weaning and regrouping). The calves were divided into groups so that the average age was about the same for all groups. The age difference between the youngest and the oldest calf in each group never exceeded three weeks. The experimental pens consisted of a straw bedded lying area and a feeding area with a concrete floor. The total pen area per calf was kept constant on 2.25 m^2 per calf for all group sizes, and each calf had access to a lying area of 1.5 m^2. The feed barrier was divided into separated feeding places (30 cm wide), and there was one feeding place per calf in all group sizes.

The calves' behaviour was video recorded for 24 hours on day 1, 3 and 11 after regrouping. Time spent feeding (standing with the head through the feed barrier), lying, standing inactive, in activity (walking or running) and exploring the pen was recorded by instantaneous scan sampling at 15 minutes intervals. Percent of total observations were calculated before analysis. When a calf was lying, the distance to the nearest lying calf was also recorded. If the distance was less than 30 cm, the calf was recorded to lie close to another calf (lie social). When lying close to another calf, the familiarity of the resting partner was also recorded. Correspondingly, when a calf was feeding, it was recorded to feed close to another calf (feed social) if another calf was feeding from one of the neighbouring feeding places. Lie social and feed social were calculated as percent of total observations lying and eating. In addition, all incidents of social interactions, displacements from feed barrier or lying area and play behaviour were recorded continuously for each calf over two 2 h periods including 0800 to 1000 h and 1600 to 1800 h on day 1, 3 and 11 after regrouping.

The effect of group size on daily activity, incidences of social interactions, displacements and play behaviour was analysed using the mixed model (MIXED) procedure of Statistical Analysis System. Differences in social interactions between familiar calves versus unfamiliar calves within group size were analysed separately for each week using a Wilcoxon two-sample test (SAS, 1990) (two-sided) for non-parametric data.

Experiment 2
At an live weight of approximately 100 kg (experiment A) and later at approximately live weight of 150 kg (Experiment B), thirty weaned dairy calves divided into six groups of five animals, were systematically rotated between three pens with different sized lying areas. In experiment A, the size of the lying areas was 0.75 m^2 per calf (small), 1.25 m^2 per calf, (medium) or 1.75 m^2 per calf (large). In experiment B, the size of the lying areas was 1.00 m^2 per calf (small), 1.50 m^2 per calf (medium) or 2.00 m^2 per calf (large). The experimental pens consisted of a straw bedded lying area of given size (small, medium or large) and an activity area with concrete floor. Total area was the same for all pens (3 m^2 per calf). Before introduction to the experiment, the calves were weighed and divided into six groups of five animals according to their age, weight, and sex, giving two batches of three groups with approximately the same average age and weight and with two male and three female calves in each group.

The calves' behaviour was video for 24 hours in each pen. Feeding (head above feed-trough), lying, standing (standing still doing nothing else) and activity (walking or running) was scored by instantaneous sampling at 10 minutes intervals. Furthermore, when a calf was lying, it was recorded if it was lying in the lying area or in the activity area and whether the distance to the nearest lying calf was more or less than 30 cm. It was also recorded whether the calf was lying recumbent (the side of the calf resting against the floor with legs stretched out) or if it was lying on sternum (lying on the belly with at least two legs folded under the body). Synchronization of the calves resting behaviour was calculated as percent of observations where all five calves in the pen were lying at the same time and percent of observation where all five calves were lying in the lying area at the same time. In addition, all incidents of social interactions and play behaviour were continuously scored for each calf from 09.00 until 11.30 h and from 17.00 until 19.30 during the 24-hours period of video recordings. The effect of size of the lying area on the calves resting and social behaviour were analysed using the mixed model (MIXED) procedure of Statistical Analysis System.

5.2.5 Results

Experiment 1
Time spent feeding and resting were not significantly affected by group size, but calves in larger groups spent more time feeding ($P < 0.05$) and lying ($P < 0.01$) close to one another than calves in groups of four (Table 1). Calves in groups of sixteen were also more active ($P < 0.05$) and spent less time standing inactive ($P < 0.05$) than calves in smaller groups (Table 1). The number of displacements from the feed barrier was higher in groups of four than in larger groups ($P < 0.05$), and more displacements were directed towards unfamiliar calves ($P < 0.01$). However, the level of agonistic behaviours and the number of displacements from the resting area, occurrence of mounting, cross-sucking, social grooming and play behaviour was not affected by group size. Calves in groups of sixteen were found laying close to familiar calves more frequently than to unfamiliar calves ($P < 0.01$) and they directed more social grooming towards familiar calves ($P < 0.01$).

Table1. Activity measures in different sized groups of calves (pooled means of day 1, 3 and 11 after regrouping). Showing least square means ± SE presented as percent of total number of observations if not other are given.

Behaviour	Group size			Effect of group size	
	4	8	16	$F_{2,6}$	P
Total feeding	18.2±1.6	22.0±1.5	22.3±1.5	2.07	ns
Feed social[1]	52.6±3.3[a]	68.0±3.0[b]	62.4±2.8[b]	6.08	< 0.05
Total lying	67.1±1.9	65.0±1.8	60.0±1.7	4.28	< 0.1
Lie social[2]	70.9±2.7[a]	91.2±2.5[b]	88.3±2.3[b]	15.20	< 0.01
Inactive[3]	4.3±0.7[a]	4.8±0.6[a]	1.2±0.6[b]	7.84	< 0.05
Active[4]	5.3±1.5[a]	5.2±1.4[a]	12.4±1.4[b]	8.29	< 0.05
Explore	3.4±0.9	1.8±0.9	3.2±0.9	1.02	ns

Means with different letters in a row between group sizes differ significantly, $P < 0.05$, ns = not significant
[1] Another calf in one of the neighbouring feeding places (% of observations feeding), [2] Another calf lying closer than 30 cm (% of observations lying), [3] Standing still, doing nothing else, [4] Walk and run

Experiment 2
Both 100 kg calves and 150 kg calves showed less synchronous lying (100 kg: $P < 0.05$ / 150 kg: $P < 0.01$), decreased recumbent lying time (100 kg: $P < 0.01$ / 150 kg: $P < 0.05$), and increased lying time close to another calf ($P < 0.001$) on the smallest lying area (Table 2 - 3). Except that 100 kg calves spent less time lying close to other calves on the medium sized lying than on the large lying area, there were no favourable effects of increasing the lying area from medium to large. There were in general few incidences of aggressive social interactions and there were no effect of the size of the lying area.

5.2.6 Discussion

The results from the experiment show that calves in larger groups were more active, competed less (fewer displacements), had increased proximity to other calves and showed stronger preference for familiar group mates when compared to calves in smaller groups. This is in accordance with our predictions and what has been found in other species (e.g. pigs: Andersen et al., 2004). The lower level of aggression in larger groups is explained by a reduced potential for resource monopolisation (Davies and Housten, 1984). In contrast to pigs and adult cattle, calves are usually not involved in costly fights. In the present study, displacements from the feed barrier to get access to concentrates were the most common aggressive interaction, whereas butting and mounting were rarely seen. As predicted, and in agreement with the findings of Bouissou and Hövels (1976), the displacements were mainly directed towards unfamiliar animals and decreased with time after regrouping. The second experiment shows that level of aggression is low, even if an attractive resource like a straw bedded lying area is limited. However, the calves resting behaviour is affected of the size of the lying area. In accordance with our predictions, a larger lying area increased synchronous resting and improved the calves' possibility to choose a recumbent resting posture. The calves were also able to keep longer distance to other individuals when lying space was large. Total lying time and time spent lying in the activity area were not affected by the size of the lying area. This is in accordance with previous studies on heifers (Nielsen et al., 1997) showing that

synchronization of resting behaviour is more sensitive to changes in space allowance than total lying time.

Table 2. Resting behaviour of 100 kg calves in relation to size of the lying area (means ±SE).

Behaviour	Size of the resting area (m^2 per calf)			$F_{2,10}$	P
	Small (0.75)	Medium (1.25)	Large (1.75)		
Total lying (% of tot.obs.)	64.65±1.11	67.29±0.73	67.12±0.79	2.28	0.15
Lying simultaneously (% of tot.obs.)	20.15±3.22a	28.60±1.60b	31.25±2.67b	4.48	<0.05
Lying simultaneously in lying area (% of tot.obs.)	18.60±3.63a	28.60±1.60b	31.25±2.67b	5.43	<0.05
Lying in lying area (% of obs. lying)	98.50±1.17	99.97±0.03	99.97±0.03	1.65	0.24
Lying in activity area (% of obs. lying)	1.49±1.17	0.03±0.03	0.03±0.03	1.65	0.24
Lying close to other calf (% of obs. lying)	87.01±1.25a	74.76±2.22a	50.02±7.15b	19.95	<0.001
Lying recumbent (% of obs. lying)	1.77±0.52a	4.32±0.52b	3.67±0.67b	7.30	<0.01
Standing (% of tot.obs.)	1.11±0.55	1.04±0.12	1.37±0.27	0.21	0.81
Active (% of tot.obs.)	7.31±0.75	6.48±0.57	6.50±0.26	0.76	0.49

Means with different letters differ significantly, $P < 0.05$

Table 3. Resting behaviour of 150 kg calves in relation to size of the lying area.

Behaviour	Size of the resting area (m^2 per calf)			$F_{2,10}$	P
	Small (1.00)	Medium (1.50)	Large (2.00)		
Total lying (% of tot.obs.)	64.93±0.53	65.81±1.00	64.91±0.67	0.69	0.52
Lying simultaneously (% of tot.obs.)	20.13±3.04a	25.25±2.05b	27.67±2.17b	10.29	<0.01
Lying simultaneously in lying area (% of tot.obs.)	18.97±3.49a	25.25±2.05b	27.67±2.17b	11.13	<0.01
Lying in lying area (% of obs. lying)	99.00±0.61	100.00±0.00	100.00±0.00	2.73	0.11
Lying in activity area (% of obs. lying)	1.00±0.61	0	0	2.73	0.11
Lying close to other calf (% of obs. lying)	91.92±1.07a	77.02±1.66b	72.83±3.11b	22.53	<0.001
Lying recumbent (% of obs. lying)	2.26±0.30a	4.14±0.58b	3.85±0.69b	4.43	<0.05
Standing (% of tot.obs.)	1.02±0.24	1.25±0.24	1.34±0.31	0.37	0.70
Active (% of tot.obs.)	11.55±0.66	9.84±1.17	10.53±0.46	1.39	0.29

Means with different letters differ significantly, $P < 0.05$

5.2.7 Conclusion

The low level of aggression and the rapid establishment of new social bonds imply that regrouping of calves after weaning is acceptable from an animal welfare point of view. However, social bonds should be taken into account and groups larger than four animals are preferable as long as age difference within the group is minimal. The smallest lying area provided in this experiment (0.75 m^2 / 1.00 m^2 per calf) was inadequate to allow synchronous resting, prevented the calves from lying recumbent with the legs stretched out, and forced the calved to rest in close proximity to other calves. The results underline the importance of adequate lying space even for animals such as calves that engage in few aggressive conflicts.

5.2.8 Litterature

Andersen, I.L., Nævdal, E., Bakken, M., Bøe, K.E., 2004. Aggression and group size in domesticated pigs, Sus scrofa: 'when the winner takes it all and the loser is standing small'. Anim. Behav. 68, 965-975.

Babu, L.K., Pandey, H.N., Sahoo, A., 2004. Effect of individual versus group rearing on ethological and physiological responses of crossbred calves. Appl. Anim. Behav. Sci. 87, 177-191.

Bouissou, M.F., Hövels, J., 1976. Effet d'un contact précoce sur quelques aspects du comportement social desbovins domestiques. Biol. Behav. 1, 17-36.
Bøe, K.E., Færevik, G., 2003. Grouping and social preferences in calves, heifers and cows. Appl. Anim. Behav. Sci. 80, 175–190.
Davies, N.B., Houston, A.I., 1984. Territory Economics. In: Behavioural Ecology: an Evolutionary Approach. 2nd Ed (Ed. by J. R. Krebs and N. B. Davies), pp 148-169. Oxford: Blackwell Scientific Publications.
Jensen, M.B., Vestergaard, K.S., Krohn, C.C., 1998. Play behaviour in dairy calves kept in pens: the effect of social contact and space allowance. Appl. Anim. Behav. Sci. 56, 97-108.
Nielsen, L.H., Mogensen, L., Krohn, C., Hindhede, J., Sørensen, J.T., 1997. Resting and social behaviour of dairy heifers housed in slatted floor pens with different sized bedded lying areas. Appl. Anim. Behav. Sci. 54, 307-316.

5.3 Utendørs oppdrett av kalver i iglo-system

Geir Næss, Hanne Solheim Hansen, Dagunn O. Moum, Høgskolen i Nord-Trøndelag
Gisle Bjerkan, Helge Stuberg, Mære landbruksskole
Kolbjørn Nybø, Nortura
Birgit Tverås, Tine

5.3.1 Sammendrag

Som en alternativ metode for oppstalling av kalv ble det bygget et iglosystem for utendørs oppstalling på Mære landbruksskole. Iglosystemet består av 2 avdelinger, hver med sin glassfiberiglo til liggeplass og et overbygd uteareal til fôringsplass. Igloene blir strødd med halm. Underlaget i utearealet er av betong og gjødsla blir skrapt med minilaster til en oppsamlingskum.

For å finne ut om dette systemet tilbyr tilstrekkelig god dyrevelferd for kalvene, samtidig som det fungerer godt for røkteren og er et rasjonelt produksjonssystem, har vi gjennomført flere registreringer i perioden 2003-2007.

I vinterhalvåret når det er kaldt, viser målinger av klimaparametere og liggetid at igloen er en god oppholdsplass som ser ut til å gi kalvene en tilfredsstillende velferd. Temperaturen inne i igloene følger utetemperaturen, og gasskonsentrasjonen ligger under de anbefalte grenseverdiene. Lufthastigheten var akseptabel, og gjennomsnittlig liggetid vinterstid var på 18 timer.
Forsøk med å strø utearealet om sommeren, viser at kalvene da har en tendens til å legge seg på utearealet, men at igloen fortsatt velges som liggeplass for de fleste kalvene.

For kalver som var eldre enn 5 uker var tilveksten svært god (>850 g/dag) og jevn for alle gruppene. For noen kalvegrupper var tilveksten de første ukene lavere og varierte mellom gruppene. Helsestatus hos kalvene var tilfredsstillende.

Alt i alt ser systemet ut til å fungere godt for kalvene, så lenge man gjør færrest mulig andre endringer for kalvene ved overgangen til iglo.

Automatisk tildeling av melk og kraftfôr gir god kontroll med hver enkelt kalv. Vi ser imidlertid at tildelingsmetoder for melk og kraftfôr kan forenkles for å spare kostnader. Når kalvene er tilvent systemet og fôrautomatene fungerer, gir iglosystemet et rasjonelt kalvestell. Det må likevel påregnes en del tid når kalvene nylig er flyttet inn i igloene og til vedlikehold av fôrautomatene.

5.3.2 Summary

Outdoor Housing system for Calves
An alternative housing system for raising calves was built at Mære Agricultural School in Steinkjer, Norway. The system consists of a simple building with two calf pens and a roof, each pen with a fibreglass igloo in connection with a feeding area. Straw works as bedding for the calves inside the igloos. The floor in the feeding area is made of concrete, and the manure is scraped by a little tractor (bobcat).

The aim of this project was to examine how this housing system works with regard to animal welfare and working conditions. The test period was from 2003-2007.

Our registrations of the climate show that the gasses were below the recommended maximum limits. The temperature inside the igloos followed the outdoor temperature, and the air velocity was acceptable. The average resting time during the winter was 18 hours/day.
In all this point in the direction of that this system offer the calves good conditions and animal welfare.

Calves older than 5 weeks had high live weight gain (>850 g/day). For some groups of calves, the weight gain was lower and uneven during the first weeks. The health conditions were satisfactory.

Altogether the igloo housing system works well, but still it is very important to reduce other changes in connection with the transfer of the calves to the igloos.

Milk and concentrate given with automatic feeders gave good control of each individual calf. When the calves were familiar with the feeders, and the automatic feeders worked well, this housing system was efficient. However, you must expect to spend more time to teach the calves to use the system, and to take care of the machinery. In the future the allocation of milk and concentrates could be done easier and with less costs by using appetite feeders.

5.3.3 Innledning

Storfe skal i følge "Forskrift om hold av storfe" (FOR 2004) være oppstallet i løsdrift fra 2024. Foreløpig er det bare 25% av norske melkekyr som oppstalles i løsdrift, og det betyr at det skal bygges mange nye fjøs de nærmeste årene. Ved planlegging av nye fjøs blir plassering av kalvene ofte en salderingspost og kalvene får en dårlig plass i forhold til miljø og smitte. En mulig løsning på oppstalling av kalv er utendørs med enkle overbygg og en mer skjermet avdeling med vegger på liggeplassen. For å få erfaringer med slike oppstallingsforhold ble det i 2003 bygget en oppstallingsplass med igloer for liggeplasser på Mære landbruksskole. For å kunne dokumentere hvordan systemet virker i forhold til kalvevelferd, helse, produksjon og arbeidsforhold, har vi sammen med studenter gjennomført registreringsperioder på 1-3 måneder siden høsten 2003. Med bakgrunn i resultatene fra disse registreringene er det laget 7 bachelorgradsoppgaver (Austvik 2004, Bakka og Volden 2004, Buflaten og Johansen 2004, Hasund og Heidenberg 2005, Bergum og Dretvik 2006, Hoset og Njå 2006, Hansen og Kalvik 2006) som til sammen gir en god oversikt over hvordan iglosystemet fungerer. Resultatene fra disse oppgavene er presentert under.

5.3.4 Resultat og diskusjon

Iglosystemet
Iglosystemet (Fig 1) er et anlegg for oppstalling av kalver i et enkelt hus uten vegger, og med iglo i glassfiber til liggeplass. Lignende system er i bruk flere steder i Europa, og hold av kalver utendørs har gitt lovende resultater i områder hvor klimaet kan sammenlignes med vårt. (Gutzwiller m.fl. 2003)
Bygningen består av to like kalveavdelinger i tilknytning til en iglo i hver avdeling. Videre er det en fôrgang og plass for 6 enkelthytter for kalver,- en mellom hver stolpe i huskonstruksjonen. Det er betonggolv i hele bygget, og overbygget er satt opp i tre. Bærende konstruksjon består av trestolper festet i søylesko, og med vindavstivende kryss i alle vegger.

Taket er bygd opp med selvbærende takstoler, takåser og fiberarmerte sementplater til taktekking.

Innredningene er laget i tre, og grindene fungerer som bingeskiller samtidig som kalvene kan stenges inn i igloene for reingjøring av aktivitetsarealet.

I hver binge er det en melkefôringsautomat og en kraftfôrautomat for individuell tildeling av melk og kraftfôr (begge automater produsert av Holm og Laue og levert av Birkeland Fjøssystemer). I hver binge er det også to vannkar med oppvarmet vann (ca 15 °C) og en høyhekk av tre. Det er plass til opptil 30 kalver om gangen i alderen 2 til 14 uker, 15 i hver avdeling.

I igloene som huser liggepass for kalvene strøs det godt med halm hver dag. Det øvrige arealet i bingen har ikke vært strødd, med unntak av noen forsøksperioder på 3-4 uker hvor det også der ble strødd med halm.

Kalvene bør være ferdig med råmelksperioden når de blir flyttet til iglosystemet og de har i praksis vært eldre enn 2 uker. I systemet kan man bruke "alt inn alt ut"-prinsippet eller man kan bruke en binge til kalv som er 2- 6 uker og en til kalv som er 6-14 uker (kontinuerlig innsetting). Det ble benyttet kontinuerlig innsetting og utflytting fra 2003 frem til høsten 2005, deretter ble det benyttet "alt inn alt ut".

Det ble brukt melkeerstatning av typen Grisegodt fra høsten 2003 til høsten 2004. Deretter har det vært brukt Sprayfo eller Kalvegodt, som er melkeerstatning beregnet for kalv. Melkeerstatningene ble utblandet med vann i anbefalt forhold. Kalvene fikk individuelle rasjoner basert på alder. Ved 2 ukers alder fikk de 8,1 liter/dag. Dette ble trappet opp til 8,8 liter/dag i 4- 6 ukers alder, deretter nedtrappet til ingen melkefôring ved 12 ukers alder. Den daglige rasjonen var fordelt på 4-8 rasjoner med maks 1,6 liter per besøk. Kraftfôr var av typen Kalvekraftfôr. Det ble i prinsippet gitt fri tilgang til kraftfôr, ved at daglig mengde ble økt når kalvene klarte å spise opp sin tildelte rasjon. Dette ble justert hver uke i noen perioder og annenhver uke i andre perioder. Kalvene hadde fri tilgang til høy og vann.

Fig. 1. Iglosystemet på Mære Landbruksskole

Miljø og kalvenes bruk av iglosystemet

For å undersøke miljøforhold for kalvene ble det hengt opp målere inne i igloene for temperatur, luftfuktighet, lufthastighet, innhold av karbondioksid (CO_2) og ammoniakk (NH_3). I samme undersøkelse ble kalvenes bruk at iglo, uteareal og fôringsområde registrert (Buflaten og Johansen 2004). Disse undersøkelsene foregikk høsten 2003 og vinteren 2004. Resultatene fra undersøkelsene viste at temperaturen i igloene fulgte svingningene i utetemperaturen og lå 1-3 °C over denne. Luftfuktighet, lufthastighet og innhold av uønskede

gasser (CO_2 og NH_3) var under de normene som anbefales for storfe (Retningslinjer for hold av storfe 2004). I januar 2006 ble det satt inn 23 kalver i alderen 8-26 dager. Kalvene kom dagen før en østlig vind i opptil liten kuling (4-12 m/sek) med temperaturer på ca -4 til -7 ° C satte inn. Den effektive temperaturen som følge av temperatur og vind var -16°C til -24°C (Gedzelman 1980). Denne værtypen holdt seg i 4 dager. I igloene var det vindstille og behagelig, mens det var svært kaldt utenfor igloene. Kalvene oppholdt seg da kun i igloene og måtte jages i fôrautomatene flere ganger daglig for å få nok fôr. Kalvene under ca 3 ukers alder skalv når de stod i fôrautomatene.

Heldøgnsstudier av kalvenes bruk at iglosystemet (Fig. 2) viste at kalvene brukte 86% av tiden til å ligge eller stå i igloene (3 døgn i løpet av januar og februar 2004 med 21 kalver i igloene). Kalvene brukte kun 3% av tiden i eller helt nært fôrautomatene og 6% av til tiden ved høyhekken og drikkekarene (Fig 2). Gjennomsnittlig liggetid hos 6 fokaldyr var over 18 timer per døgn. Det er anbefalt at kalver bør ligge opp mot 16 timer i døgnet (Krohn 1999), Liggetid er en velferdsindikator hos kalv og resultatene tyder på at kalvene trives i iglosystemet. Det ble heller ikke funnet vesentlige stereotypier (uønsket atferd som oppstår i ensformige omgivelser) hos kalvene. Vanligste stereotypier hos kalv er utpreget suging på andre kalver eller innredning samt tungerulling. Kun for ett innsett av kalver, i registreringsperioden januar til mars 2006, måtte en kalv tas ut av systemet på grunn av desperat suging på de andre kalvene i bingen. Kalven viste denne atferd allerede da den ble satt inn i iglosystemet.

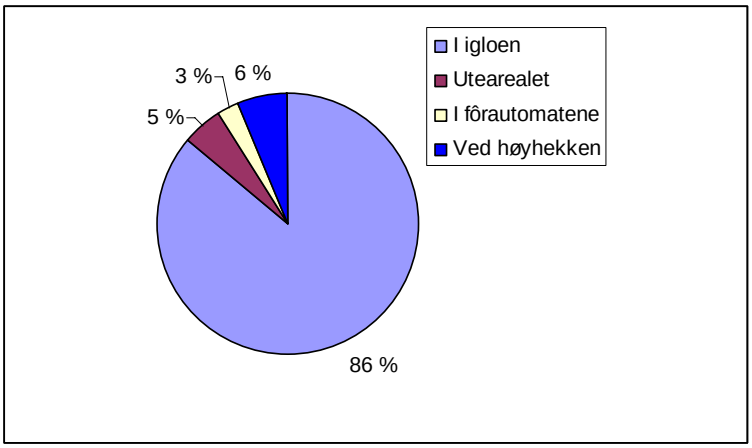


Fig. 2. Tid brukt til opphold i ulike deler av iglosystemet. Gjennomsnitt av 3 døgn med 21 kalver (Etter Buflaten og Johansen 2004)

I igloene kan det brukes ulike strømidler. Halm er et godt liggeunderlag for kalver i utendørs oppstalling (Hansen og Jørgensen 2006). Halm er imidlertid ikke like tilgjenglig alle steder i landet og det ble derfor testet om det var aktuelt å bruke en blanding av halm og trespon (Hasund og Heidenberg 2005). I den ene testen av liggeunderlag som ble gjennomført viste kalvene preferanse for underlag av blandingen halm og spon. Det var imidlertid liten forskjell i preferanse og resultatene bør verifiseres før det endelig konkluderes. Det ble også forsøkt å strø utearealet med halm sommerstid (Hasund og Heidenberg 2005). Disse undersøkelsene viste at kalvene hadde en tendens til i større grad å legge seg ute sammenlignet med inne i igloene. Det var først og fremst de største kalvene som valgte å ligge ute når dette arealet var strødd. Den mest foretrukne liggeplassen var likevel inne i igloene.

På grunnlag av de ovennevnte undersøkelsene har vi vurdert det fysiske miljøet til være tilfredsstillende. Iglosystemet dekker kalvenes atferdsbehov og vi mener at kalvenes velferd er tilfresstillende ivaretatt i iglosystemet. Vi vil likevel anbefale at det brukes vindskjerming

rundt bingen i form av vindbremseduk eller vegger for å gjøre systemet mer robust overfor kald vind.

Tilvekst

Det har blitt målt tilvekst hos 84 kalver i iglosystemet (Austvik 2004, Bakka og Volden 2004, Bergum og Dretvik 2006, Hoset og Njå 2006). Kalvene ble veid på digital plattformvekt en eller to ganger i uken. I alderen 2-4 uker hadde kalvene i de ulike gruppene en gjennomsnittlig tilvekst på 0-900 g/dag (Fig 3). Hos kalvene i igloene vinteren 2004 ble det registrert en gjennomsnittlig tilvekst på 0 g/dag. Det vil si at noen kalver la på seg og andre tapte vekt i denne perioden. Også i senere innsett har enkeltindivider hatt liten tilvekst eller tapt vekt den første uken i systemet. De aller fleste kalvene var nyankommet i iglosystemet i denne alderen. For å gjøre overgangen til iglosystemet enklest mulig for kalvene er det viktig at man gjør minst mulig andre endringer for kalvene i den perioden. Flytting medfører nytt system, ny plass å finne fôr, nye kalver og ny rangorden å forholde seg til for hver av kalvene. Det er derfor viktig å blant annet sørge for at fôr og fôring er tilnærmet lik før og etter flytting og det er selvsagt viktig å unngå avhorning i denne perioden. Den første uken er det også nødvendig å hjelpe kalvene til å lære å bruke melkefôringsautomaten og kraftfôrautomaten.

Fra 5 ukers alder til 16 ukers alder var gjennomsnittlig daglig tilvekst mer jevn mellom kalvegruppene og den varierte fra 580 g/dag til 1180 g/dag (Fig 3). Gjennomsnittlig tilvekst for hele perioden fra 2 til 16 uker for hver av kalvegruppene varierte fra ca. 622 g/dag til 1104 g/dag, avhengig av alder på kalvene og årstid for målingene. Med unntak av gruppen med tilvekst på 622 g/dag er dette svært god tilvekst i forhold til danske feltundersøkelser der gjennomsnittlig tilvekst var fra 580 g/dag til 760 g/dag (Engelbrecht 2006) og fra 545 g/dag til 674 g/dag (Dalgaard 2005).

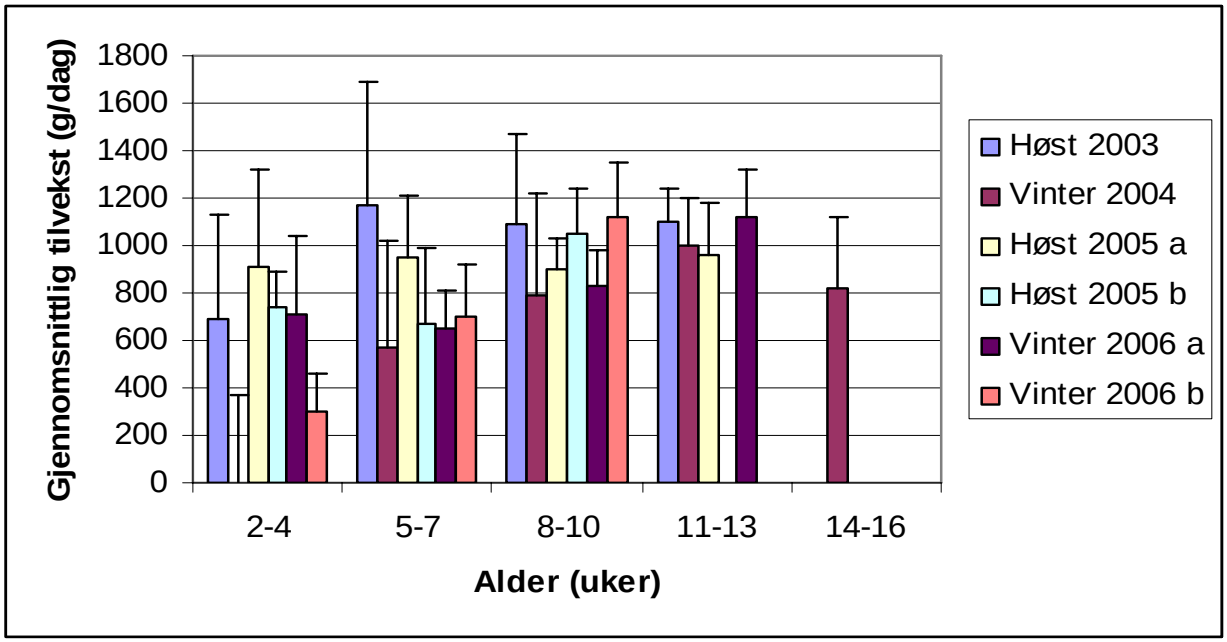


Fig 3. Gjennomsnittlig tilvekst hos seks grupper med kalver i iglosystemet fra høst 2003 til vinter 2006. Gjennomsnitt av 2- 20 kalver for hver av aldersperiodene. I forsøksoppsett 2005 a og 2006 a fikk kalvene kraftfôr fra kraftfôrautomat, mens i forsøksoppsett 2005 b og 2006 b fikk de kraftfôr fra appetitt-fôringsautomat. (Etter Austvik 2004, Bakka og Volden 2004, Bergum og Dretvik 2006, Hoset og Njå 2006)

Tilveksten var stort sett svært god for kalvene i iglosystemet. Det var imidlertid den første eller de to første ukene etter flytting som synes å være vanskeligst, og som også resulterte i lavere tilvekst for noen av kalvegruppene. Det betyr at kalvene krever nøye oppfølging de

første 1-2 ukene og at det må legges vekt på å gjøre færrest mulig andre endringer for kalvene i forbindelse med at de flyttes til igloene. Kalvene må også læres opp til å bruke fôrautomatene.

Helse
Hos kalv er de viktigste sykdommene diaré, luftveisinfeksjoner og navle- og leddbetennelse. I to grupper med 48 kalver (høsten 2005 og vinteren 2006) der helsetilstanden ble registrert nøye, var det en kalv som døde av infeksjon i løpen, en kalv med luftveisinfeksjon og 3 veterinærbehandlinger av diaré hos to kalver. I tillegg ble det de første to ukene gitt 1,5 liter elektorlyttblanding både morgen og kveld til alle kalver med den minste antydning til fôringsbetinget diaré. I hvert av innsettene var det 6 og 8 kalver som hadde lettere fôringsbetinget diaré i korte perioder i løpet av de første 14 dagene i iglosystemet. Vi har ikke gode sammenligningstall for helseproblemer hos kalv, men en dødelighet på 2% for iglokalvene er lavt i forhold til ca. 3% som regnes for normalt for aldersgruppen 2-12 uker (Helsetjeneste storfe 2000). De mindre helseproblemene som luftveisinfeksjoner og diaré har vi ingen sammenligningstall for.

Fôrforbruk
Fôrforbruk ble registrert individuelt hos 24 kalver høst 2005 og vinter 2006 (Bergum og Dretvik 2006). Forbruk av melk og kraftfôr, vekt og tilvekst ble registrert for individuelle kalver to ganger i uken hos kalver i alderen 2 til 16 uker. Resultatene viste at fôrforbruket til tilvekst i gjennomsnitt var 0,50 FEm/kg tilvekst. Tilsvarende resultater (0,70 FEm/kg tilvekst) ble funnet av Hoset og Njå (2006) for 25 kalver, der kraftfôrforbruket ble registrert gruppevis. Det registrerte fôrforbruket til tilvekst er betydelig lavere enn de normene som brukes for storfe (3 FEm/kg tilvekst, Harstad 1994). Lavere fôrforbruk hos kalvene i iglo kan stemme med at undersøkelser av energiforbruk til tilvekst hos storfe stort sett har vært gjort med eldre dyr som normalt vil ha høyere andel fettavleiring i tilveksten. Høyere andel fett betyr mer energi i tilveksten og derfor større fôrforbruk til tilvekst. En del av tilveksten hos unge kalver er utvikling og vekst av fordøyelsessystemet, som innholder mye vann, og som det derfor krever lite energi å lage (Sehested m fl. 2003). Dersom vi kan verifisere disse resultatene vil de være av betydning for fremtidige normer for energi til kalv. Resultatene betyr også at de normene vi bruker i dag er tilstrekkelig til å dekke både behovet for energi til tilvekst og behovet for varmeproduksjon, når dyrene er oppstallet utendørs i kalde perioder.

Fôringssystemer
Ved bygging av iglosystemet ble det installert kraftfôrautomat med individuell tildeling. Denne automaten var dyr i innkjøp og det var aktuelt å teste muligheten for enklere system for tildeling av kraftfôr. Det ble derfor satt opp en enkel appetitt-fôringsautomat for kraftfôr med plass til ca 40 kg kraftfôr om gangen i den ene bingen. Tilvekst, atferd og fôrforbruk ble registrert hos to grupper kalv (14 kalver høsten 2005 og 11 kalver vinter 2006, Hoset og Njå 2006). Resultatene viste at kraftfôrautomat med individuell tildeling gav god oversikt over de enkelte kalvene, ga ro til eting, var kostnadskrevende i innkjøp og var lite driftssikker under vinterforhold (Tabell 1). Appetitt-fôringsautomat for kraftfôr ga ikke mulighet for individuell kontroll av kraftfôrforbruket, den var billig i innkjøp og den var svært driftssikker. Det var imidlertid en del mobbing bort fra appetitt-fôringsautomaten, av 82 besøk ble kalvene i 34% av besøkene jaga bort av andre kalver (Hoset og Njå 2006). Derfor var appetitt-fôringsautomaten en mindre sikker tildelingsmetode enn kraftfôrautomat med bakport, der alle individer fikk ete i fred. Det var samme gjennomsnittlige kraftfôropptak og tilvekst hos kalv som fikk kraftfôr med begge systemene.

Tabell 1. Sammenligning av fôropptak, tilvekst hos kalv, driftssikkerhet, arbeidsinnsats og individkontroll ved tildeling av kraftfôr ved hjelp av kraftfôrautomat eller appetitt-fôringsautomat for kraftfôr (Etter Hoset og Njå 2006).

	Positivt	Negativt	Likt
Kraftfôrautomat	Godt system for individuell oppfølging Liten frekvens av jaging når bakport er montert	Mindre driftssikker Krever mye oppfølging	Gjennomsnittlig kraftfôropptak
Appetitt-fôringsautomat for kraftfôr	Veldig driftssikker Enkel i bruk	Liten oversikt over individuelt fôropptak Vanskelig å skjerme for jaging	Gjennomsnittlig tilvekst

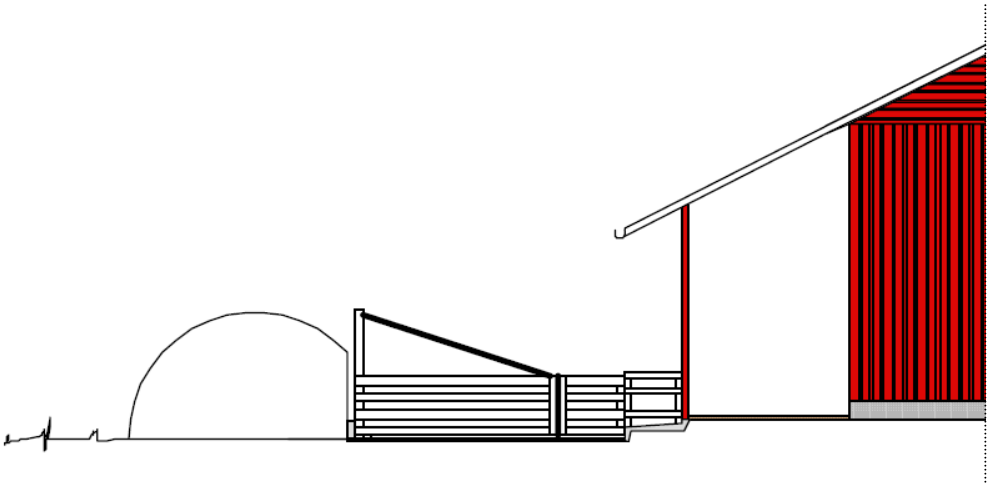
Arbeidsforbruk

Det ble gjort tidsstudier for arbeidet med stell av dyr og fôring vinteren 2006. På dette tidspunkt var det 22 kalver som var i iglosystemet 2. og 3. uke (Hansen og Kalvik 2006). Til daglig stell og oppfylling av fôr ble det i gjennomsnitt brukt 26 min/dag. Det vil si at de dagene det ikke var behov for ekstraordinære gjøremål tok daglig stell 1,2 min per dyr per dag. Til ekstraordinære gjøremål, som tildeling av elektrolyttblanding, opplæring av kalver i bruk av fôrautomater, og fiksing av fôrautomater ble det i gjennomsnitt brukt 80 min per dag. Av de ekstraordinære gjøremålene var tildeling av elektorlyttblanding den arbeidsoppgaven som tok mest tid (henholdsvis 54 min/dag og 18 min/dag for de to registreringsukene). Tildeling av elektorlyttblanding ble sterkt redusert allerede andre registreringsuke og deretter ble elektorlyttblanding tildeling bare sporadisk. Det som tok nest mest ekstra tid var fiksing av melkefôringsautomaten. Dette skyldes deler i automaten som burde vært skiftet og som forårsaket at slanger med melk frøs, slik at automaten stanset. Den første registreringsuka ble det brukt i gjennomsnitt 31 min per dag til fiksing av melkefôringsautomaten.
Det vil være aktuelt å bygge inn selve foringsautomaten slik at den står frostfritt. Sugestasjonene kan likevel stå ute. Dette vil sannsynligvis gi mindre problemer med drift av automaten.

Siden kalvene nylig var satt inn i iglosystemet ble det også brukt en del tid på å hjelpe kalvene i fôrautomatene (henholdsvis 16 min/dag og 8 min/dag i de to registreringsukene). Fjerning av talle fra begge igloene tok ca 1 time og 10 min (Hansen og Kalvik 2006). Dette bør gjøres 3-4 gange i løpet av året, avhengig av antall kalver og alder på kalvene.

Alternative system

I dette prosjektet ble det bygd en frittstående bygning til formålet. Det innebærer en del grunnlagskostnader til bl.a. strøm, vann og avløp. Et lignende anlegg i tilknytning til en annen driftsbygning vil kunne redusere disse kostnadene, og derfor være økonomisk interessant i flere tilfeller. Det ser ut til at det ofte er vanskelig å finne gode løsninger for oppstalling av kalver også i nye driftsbygninger for melkeproduksjon. Et utendørs anlegg for kalveoppdrett i tilknytning til fjøset for melkekyr, kan her være en interessant løsning (Fig. 4).



Figur 4. Eksempel på bruk av igloer i tilknytning til en annen driftsbygning (etter Hansen og Kalvik, 2006)

5.3.5 Konklusjon

Det fysiske miljøet i iglosystemet er tilfredsstillende, og atferden til kalvene tyder på at de trives i systemet. Helsesituasjonen til kalvene er tilfredsstillende. Tilveksten til 3 måneders alder er svært god. Det er imidlertid viktig å gjøre minst mulig endringer for kalvene når de flyttes i igloene, slik at overgangen til iglosystemet blir lettere for kalvene. De normene som brukes for fôring av kalv ser ut å overvurdere behovet for energi til tilvekst, slik at dagens normer dekker både behovet for energi til tilvekst og varmeproduksjon i de kalde periodene. Kraftfôret kan gjerne tildeles med en helt enkel appetitt-kraftfôrautomat. Når det gjelder strø er det mulig å tilpasse bruken til det som er lettest tilgjengelig, enten halm eller spon eller helst en kombinasjon av halm og spon. Strøing av utearealet sommerstid viser en tendens til at flere av de største kalvene velger å legge seg ute, men det er fortsatt igloene som er den dominerende liggeplassen. Når kalvene er tilvent systemet og fôrautomatene fungerer, er det veldig rasjonelt å stelle kalvene i iglosystemet. Det må likevel påregnes en del tid når kalvene nylig er flyttet i igloene og til vedlikehold av fôrautomatene.

Alt i alt fungerer iglosystemet godt for oppstalling av kalv. Kalvene har det godt, de har god tilvekst og arbeidsforbruket er svært lavt når alt går vel, men det kan i problemperioder kreve en del arbeid. Det er også viktig å sette av nok tid til kalvene den første eller de to første ukene de er i igloene.

5.3.6 Litteratur

Austvik, K.A. 2004. Tilvekst hos kalv i iglosystem. Bacheloroppgave Høgskolen i Nord-Trøndelag.

Bakka, S., Volden, I. L. 2004. Kalveoppdrett utendørs – energibehov, fôropptak og tilvekst. Bacheloroppgave Høgskolen i Nord-Trøndelag.

Buflaten. K., Johansen, R. M. 2004. Kalveiglo – klima og adferd. Bacheloroppgave Høgskolen i Nord-Trøndelag

Bergum, W., Dretvik, I. 2006. Fôropptak og tilvekst hos utegående kalv i Norge. Bachelorgradsoppgave Høgskolen i Nord-Trøndelag.

Dalgaard, I. (2005) Kalvestalde kontra kalvehytter. Tilvekst, sundhed og arbejdsforhold. I *Kvæg* nr. 18 2005. Dansk Landbrugsrådgivning

Engelbrecht, R. 2006. Giv dine kalve bedre tilvækst og sundhed. Dansk kvægs kongress 2006.

27. og 28. februar Herning Kongrescenter. http://www.lr.dk/kvaeg/diverse/tema13-2006.htm
Opprettet 03.01.06, hentet 19.07.06
FOR 2004-04-22 nr 665: Forskrift om hold av storfe. 2004. Landbruks- og matdepartementet. http://www.lovdata.no/for/sf/ld/td-20040422-0665-0.html
Hentet 25.07.06
Gedzelman, S. D. 1980. The Science and wonders of the atmosphere. John Wiley and Sons, New York, Chichester, Brisbane, Toronto. ISBN 0-471-89103-7
Gutzwiller, A. & Morell, I. 2003. Igluhaltung von neugeborenen Kälbern im Winter. Agrarforschung 10 (2), 70-74
Hansen, I., Jørgensen, E. 2006. Velferd hos kalver i kaldfjøs. Delprosjekt under pilotprosjektet "Landbruksbygg i Arktis" Bioforsk Rapport. Vol 1 nr 67. ISBN 82-17-00059
Hansen, H. K., Kalvik, Å. 2006. Utendørs kalveanlegg – kostnader og forbedringsområder. Bachelorgradsoppgave Høgskolen i Nord-Trøndelag..
Hansen, H. S., Sakshaug, A., Fløttum J. 2003. Optimal produksjon av kalv. Kompendium fra Høgskolen i Nord-Trøndelag. ISBN 82-7456-313-1
Harstad, O. M. 1994. Fôrmiddelvurdering og fôrutnyttelse hos drøvtyggere. Kompendium ved Norges landbrukshøgskole, Landbruksbokhandelen. ISBN 82-557-0408-6
Hasund, K., Heidenberg, J. 2005. Liggeunderlag og atferd hos kalv i iglo. Bachelorgradsoppgave Høgskolen i Nord-Trøndelag.
Helsetjenesten for storfe. 2000. Ta vare på kalven. Fremtida i fjøset. Helsetjenesten for storfe. Fagperm 109 sider
Hoset, S., Njå. I. 2006. Kraftfôrtildelingsmetoder for kalv i kalde omgivelser. Bachelorgradsoppgave Høgskolen i Nord-Trøndelag..
Krohn, C.C. 1999. Kvæg. I *Etikk, velfærd og adfærd i husdyrbruget*, red. S.K.Nielsen, Landbrugsforlaget, Århus. ISBN 87-7470-728-0
Retningslinjer for hold av storfe. 2005. Mattilsynet http://www.mattilsynet.no/mattilsynet/multimedia/archive/00014/Revidert_retningslin_14655a.pdf. Hentet 25.07.06
Sehested, J., Pedersen, R. E., Strudsholm, F., Foldager, J. 2003. Spædkalvens fordøjelsesfysiologi og ernæring. I *Kvægts ernæring og fysiologi, bind 2 – Fodring og produktion*, red. F. Strudsholm og K. Sejrsen, Danmarks JordbrugsForskning. ISSN 1397-9892

6 Calf welfare and etics

6.1 Early weaning of calves – a behavioural problem?

Knut Egil Bøe and Inger Lise Andersen
Norwegian University of Life Sciences, Department of Animal- and Aquacultural Sciences, 1432 Ås, Norway

6.1.1 Abstract

Effect of early weaning from milk replacer and access to teat buckets was investigated by conducting a 2 x 2 factorial experiment with age at weaning (6 or 13 weeks) and access to teat buckets (permanent or 15 minutes during feeding) as main factors. A total of 48 dairy calves in 8 subgroups of six calves were used in the experiment. The calves were videorecorded for two consecutive days the week before weaning, the two first days after weaning and at 20 weeks of age, and the frequency of oral behaviors was scored continuously. The frequency of sucking/licking pen fittings and naval/genitals increased the first two days following weaning, and then decreased to a low level at 20 weeks of age. There were no significant effects of age at weaning or access to teats on these behaviours. The mean frequency of tongue-rolling was significantly higher for early weaned than for late weaned calves, 2.2 and 0.2 respectively ($P < 0.05$). The results indicate that early weaning from milk replacer have no significant effect on sucking and licking behaviour but the incidence of tongue-rolling was higher in early weaned calves.

6.1.2 Sammendrag

Effekt av tidlig avvenning og tilgang på spenebøtter ble undersøkt i et 2 x 2 faktorielt forsøk med alder ved avvenning (6 og 13 uker) og tilgang til spenebøtter (kontinuerlig eller bare 15 minutter ved fôring) som hovedfaktorer. Totalt 48 NRF-kalver ble delt inn i 8 grupper a 6 kalver ble brukt i forsøket. Kalvene ble videofilmet to påfølgende dager før avvenning, de to første dagene etter avvenning og to dager ved 20 ukers alder. Frekvensen av suge og slikke på bingedetaljer og navle/genitalier økte de to første dagene etter avvenning, men ble redusert til et lavt nivå ved 20 ukers alder. Det var ingen effekt av alder ved avvenning og tilgang til spenebøtter. Frekvensen av tungerulling var høyere for tidlig avvente kalver enn for sent avvente kalver, henholdsvis 2,2 og 0,2 ($P < 0,05$).

6.1.3 Introduction

The age at which dairy calves are weaned from milk replacer (the time when the feeding of milk replacer is terminated) has decreased, and many calves in commercial dairy herds are weaned at the age of 5 to 6 weeks. The main reasons for terminating the milk feeding earlier are less labor requirements and that concentrates usually are cheaper than milk replacer. Daily gain has shown to be fully acceptable when practicing early weaning in calves, but we have

little knowledge about how early weaning affect the behaviour. Research on other mammalien species show that early weaning, which then involve both separation from the mother and termination of milk feeding, entail behavioural problems. A higher frequency of stereotypies was found in early weaned mink (Jeppesen et al., 2000), whereas an increased frequency of sucking and massaging is reported in early weaned piglets (e.g. Bøe, 1993). Experimental data indicate that cross-sucking was reduced after weaning in late weaned dairy calves (Lidfors, 1993). The taste of milk appears to be important for stimulating sucking (Rushen and de Passilé, 1995), but it is questionable whether the absence of milk actually will reduce incidence of cross-sucking imposing early weaning.

Calves with an unsatisfied need for suckling, will suck and lick more at the mouth/ears, naval/genitals and pen fittings and may perform excessive self-grooming (Hafez and Lineweaver, 1968; de Wilt, 1985; Lidfors, 1993). Experiments have shown that cross-sucking is reduced when milk is fed in teat buckets rather than ordinary buckets (e.g. de Wilt, 1985; Bøe, 1988), and that calves direct a lot of their motivation for sucking towards the rubber teats. When using teat buckets, some farmers remove the teat bucket shortly after the milk is ingested, whereas others allow the calves' continuous access to the teat bucket. This experiment aims to clarify how early weaning and having permanent access to teat-buckets affects oral behaviors (non-nutritive) in group-housed dairy.

6.1.4 Materials and methods

The experiment had a 2 x 2 factorial design with weaning age (time when feeding of milk replacer is terminated) and access to teat-buckets as main factors. Two groups were weaned late (age 13 weeks) and two other groups were weaned early (age 6 weeks). Half of the groups had access to the teat-buckets during milk-feeding only (approximately 15 minutes per meal) and the other half of the groups had permanent access to the teat buckets (24 hours a day).

Animals, housing and feeding
The experiment was carried out over two consecutive years from 1996 - 1998 at the Agricultural University of Norway. The experiment involved a total of 48 male and female dairy calves of Norwegian Red Cattle breed. The calves were placed in groups of 6, with 3 male and 3 female calves in each pen, after the colostrum-feeding period was finished, usually 4 to 5 days after birth. All the calves within each group were born within 7 days. The experiment was terminated at 20 weeks of age.

Each of the pens was 2.7 x 3.4 m (1.5 m^2 per calf) with wooden slatted floor at the feeding barrier and a 1.2 m solid floor lying area in the back of the pen. Teat-buckets, one for each calf, were placed over the feeding barrier. The calves were offered 4 – 5 liters per day of a commercial milk replacer (16.7 MJ ME per kg and 179 g digestible protein per kg). The milk replacer was fed warm from teat-buckets twice daily at 08.15 and 14.15 hours. To avoid inter-sucking, the calves were constrained in the barrier for 15 minutes during milk feeding. Concentrates and hay were fed ad libitum, but the consumption of concentrate (150 g/kg digestible protein) was restricted from the age of 6 weeks to 1.5 kg/calf for the early weaned calves and 1.0 kg for the calves weaned late.

Behavioral observations
The calves were videorecorded for two consecutive days from 7.30 to 15.30 hours at 4 different ages Weaned early: 5 (before weaning), 6 (after weaning = first two days of no milk-feeding), 13 and 20 weeks of age; Weaned late: 6, 12 (before weaning), 13 (after weaning = first two days of no milk-feeding) and 20 weeks of age. The frequency of 5 mutually exclusive behaviors, performed while the animals were standing up, excluding the 15 minutes they were constrained in the feeding barrier at milk feeding, were scored continuously. In addition, the duration of sucking and licking at the naval or genitals of another calf was recorded.

Statistics
The data were analyzed using a non-parametric analysis of variance. The data were ranked and subjected to a GLM-procedure (Hatcher and Stepanski, 1994) using mean per group as statistical unit.

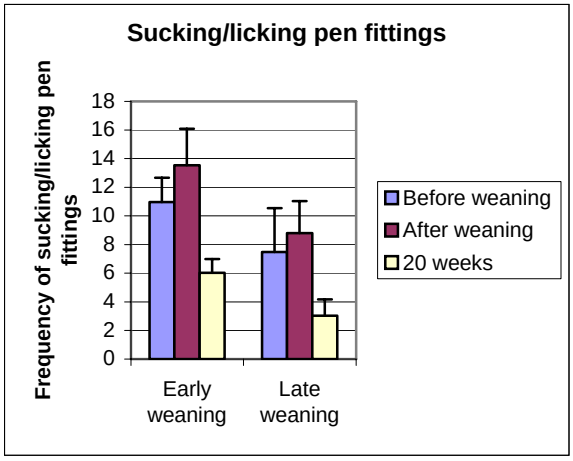
6.1.5 Results

Sucking and licking pen fittings was the most frequent oral behaviour, with an average of 8 to 10 events per day (8 hours). Sucking and licking naval and genitals occurred less frequent with an average of 2 –4 events per observation day, whereas sucking and licking mouth and ears only had a frequency of 0.6 to 0.8 events per observation day.

Sucking/licking pen fittings
Both for early and late weaned calves, the frequency of sucking/licking pen fittings increased the first two days following weaning, and had decreased to a lower level at 20 weeks of age (Figure 1). The incidence of sucking and licking pen fittings was somewhat higher in early weaned calves both before and after weaning, but this difference was not significant.

Permanent access to teat buckets did not reduce the frequency of sucking/licking pen fittings either before or after weaning.

Sucking/licking naval and genitals
The frequency of sucking/licking naval and genitals increased after weaning and then decreased again (Figure 2). However, no significant differences between treatments could be demonstrated. All the calves were observed performing sucking/licking naval and genitals at least once at 20 weeks of age. Frequency of sucking and licking naval and genitals tended to be lower among calves with permanent access to teat buckets both before (1.63 vs. 3.42) and after (2.65 vs. 6.25) weaning, but the difference was not significant.



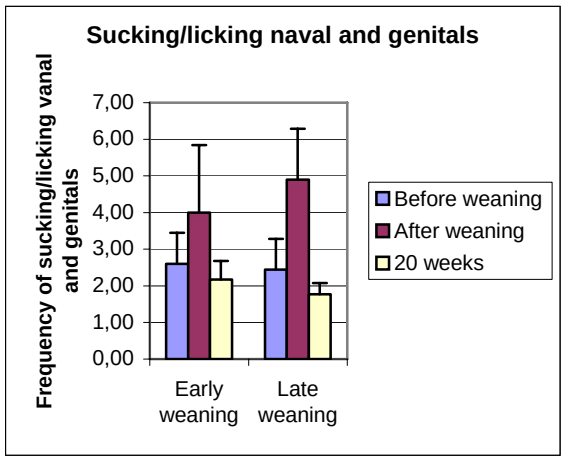


Figure 1 and 2. Sucking and licking pen fittings and naval/genitals (mean ± se).

Sucking/licking mouth and ears

The frequency of sucking and licking mouth and ears decreased after weaning and continued to decrease to a low level at 20 weeks of age (Figure 3). However, there was no significant effect of age at weaning. At 20 weeks of age, 7 of 24 calves in the early weaning treatment performed this behaviour 1 –3 times. In the late weaning treatment, 10 of 24 calves were observed performing this behaviour. Permanent access to teat buckets did not reduce the frequency of sucking/licking mouth/ears either before or after weaning.

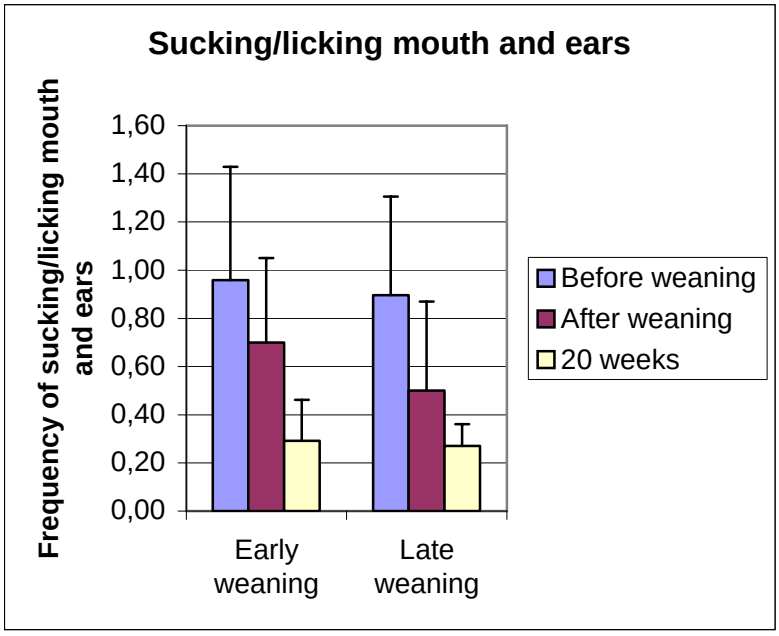


Figure 3. Sucking/licking mouth and ear (mean ± se).

Tongue-rolling

Tongue-rolling appeared to increase over time and at 20 weeks of age 18 of the 48 individuals performed this behavior. The two calves that performed tongue-rolling most frequently were both weaned early. Overall, the mean frequency of tongue-rolling at 20 weeks of age was

significantly higher for early weaned than for late weaned calves, 2.2 and 0.2 respectively ($P < 0.05$).

Performance
The daily gain was very satisfactory in all treatments. However, the daily gain from 0 to 20 weeks of age was significantly higher in the groups weaned late than groups weaned early, 776 g/day and 712 g/day respectively. The consumption of concentrates increased faster in the early weaned groups than the late weaned groups, and the early weaned groups reached their maximum ration of 1.5 kg/day at 8 weeks of age.

6.1.6 Discussion

Early weaning did not have any significant effect on sucking and licking directed towards mouth/ears, naval/genitals or pen fittings. However, an increase in sucking and licking directed towards naval/genitals and pen fittings the two first days after termination of the milk feeding was present both in early and late weaned calves. Both the constraint of the calves in the barrier during milk feeding and provision of new concentrates every day are recommended measures that are known to reduce cross-sucking (Kittner and Kurz, 1967). Hence, the generally low level of sucking and licking can be explained by these measures.

Results from Rushen and Passille et al. (1995) indicate that it is the ingestion of milk that elicit sucking. However, the higher level of sucking and licking pen fittings and naval/genitals the two first days after weaning in the present experiment show that other factors also can be involved in sucking motivation. At 20 weeks, the frequency of sucking and licking was on a low level, and even if we do not know how fast the frequency decreases after weaning, we have reason to believe that it drops rather quickly. The increased frequency after weaning can be related to the calves' expectation of getting milk triggered by the sight of the caretaker providing hay and concentrates or by the sight and smell of other calves drinking milk. As the teat buckets had been removed, and hence there was no teat to suck on, more sucking and licking was directed towards pen fittings and neighbouring calves. Data from experiments with calves within the milk feeding period (e.g. Bøe, 1988) and practical experience show that sucking and licking increase just before milk feeding, which clearly indicates that expectation of getting milk per se is an important triggering factor for sucking motivation. The expectation of getting milk will probably decline rapidly and vanish 2 to 3 days after weaning. Calves on pasture start to eat grass rather early and the early weaned calves in the present experiment increased the consumption of concentrates rapidly after weaning. The differences in daily weight gain between early and late weaned calves were also relatively small. This indicate that the calves' digestive tract already at 5 weeks of age is so well developed that a transition to other feed than milk apparently can be done without problems. Thus, to maintain a high motivation to suck seem not to be functional, which may explain the low frequency of sucking and licking in the early weaned calves.

Permanent access to teats had no effect on sucking and licking before weaning. The motivation to suck is very high when the calves start consuming their milk ration, but declines rapidly, and 15 minutes afterwards it is almost negligible (Graf et al., 1989). The calves with permanent access to teats also sucked and licked on them after the 15 minutes of restraint in the barrier, but the frequency of sucking and licking was rather low. As all calves had access to the teats during the 15 minutes of milk feeding, the absence of any effect of permanent

access to teat buckets is reasonable. Considering the fact that permanent access to teats had no effect before weaning, it was not surprising that no effect was present after weaning either.

Tongue-rolling appeared to increase over time, and the early weaned calves had a significantly higher incidence of tongue rolling at 20 weeks of age than the late weaned calves. In comparison, Jeppesen et al. (2000) found a higher frequency of stereotypies in early weaned mink. Even though the general relation between stereotypies and animal welfare is yet unclear (Mason, 1991), the higher level of tongue-rolling in early weaned calves may indicate reduced welfare. Interestingly, data from dairy cows (Redbo, 1992) show that the restrained animals ceased to perform oral stereotypies when moved to loose housing.

6.1.7 Conclusion

Early weaning (5 weeks of age) of dairy calves from milk replacer did not have any significant effect on sucking and licking directed towards mouth/ears, naval/genitals or pen fittings. But the frequency of tongue-rolling tended to be higher in early weaned calves. As early weaning require less labour, this practice can be recommended when the health conditions are satisfactory and the costs of concentrates are lower than milk or milk replacer.

6.1.8 Literature

Bøe, K., 1988. Behaviour of calves in different pen- and milk feeding systems. In Proceedings of the International Congress on Applied Ethology in farm animals Skara 1988 (eds. J. Unshelm, G. van Putten, K. Zeeb og I Ekesbo), 224-227.

Bøe, K.E, 1993. The effect of age at weaning and post-weaning environment on the behaviour of pigs. Acta Agric. Scand. Sect. A, 43: 173 – 180de Wilt, J.G., 1985. Behaviour and welfare of veal calves in relation to husbandry system. IMAG, Wageningen. 138 pp.

Graf, B., Verhagen, N. And Sambraus, H.H., 1989. Reduction of substitute sucking in artificially reared calves by retraining after feeding or prolongation of sucking time. Züchtungskunde, 61: 384 – 400.

Hafez, E.S.E. and Lineweaver, J.A., 1968. Suckling behaviour in natural and artificially fed neonate calves. Z. Für Tierpsychologie, 25: 187 – 198.

Jeppesen, I.L, Heller, K.E. and Dalsgaard, T., 2000. Effects of early weaning and housing conditions on the development of stereotypies in farmed mink. Appl. Anim. Behav. Sci., 68: 85 – 92.

Kittner, M. and Kurz, H., 1967. Ein Beitrag zur Frage des Verhalten der Kälber unter besonderer Berücksichtigung des Scheinsaugens. Archiv für Tierzucht, 10: 41-60.

Lidfors, L.M., 1993. Cross-sucking in group housed dairy calves before and after weaning off milk. Appl. Anim. Behav. Sci., 38: 15 – 24.

Mason, G.J., 1991. Stereotypies: a critical review. Anim. Behav., 41: 1015 – 1037.

Redbo, I., 1992. The influence of restraint on the occurrence of oral stereotypies in dairy cows. Appl. Anim. Behav. Sci, 35: 115-123.

Rushen, J. and de Passilé, A.M.B., 1995. The motivation of non-nutritive sucking in calves Bos taurus. Anim. Behav. 49, 1503 – 1510.

6.2 Velferd hos kalver - resultater fra to undersøkelser

Inger Hansen
Bioforsk Nord Tjøtta, N-8860 Tjøtta, Norway

6.2.1 Abstract

Welfare studies performed through the project ”Landbruksbygg i Arktis” (free stall, cold-housing for dairy cows in the Arctic) show that calves at 1-6 months of age react to cold climate by lying significantly less and standing more of the time. Reduced lying time indicates that the bedding material used is not optimal regarding good lying comfort. If calves younger than four weeks are to be housed in cold buildings, it is necessary to offer them a partly insulated laying area. Older calves should have bedding materials with low heat conductance (good insulation capacity). In cold, as well as in warm buildings for milk production, it is the farmer which is the most important factor ensuring animal welfare. When building a new cowshed, there are examples that the farmer’s own effort during the construction period runs at the expense of a sufficient calf management. A good calf management, based on good routines for colostrum feeding and a dry and draught-proof environment is essential to obtain high quality calf welfare. There are additional challenges regarding cold-housing of animals due to wind and weather that suddenly may change the indoor climate. Hence, extra responsibility is put upon the farmers and their management of cold buildings.

6.2.2 Sammendrag

Velferdsstudier utført på kalver i prosjektet ”Landbruksbygg i Arktis” viser at kalver på 1-6 måneders alder i uisolert bygg reagerer på kulde ved å stå signifikant mer og ligge desto mindre. Redusert liggetid indikerer at liggeunderlaget brukt i denne studien ikke var optimalt med hensyn på å sikre god liggekomfort. Dersom spedkalver skal oppstalles i kaldfjøsanlegg, er det nødvendig å tilby disse en delvis isolert liggeavdeling. Til litt eldre kalver bør det benyttes liggeunderlag med lav varmeledningsevne. I isolerte som i uisolerte fjøs er det røkteren som er den viktigste faktoren med hensyn til å sikre god dyrevelferd. Ved nybygging av fjøs er det eksempler på at stor egeninnsats under byggeprosessen kan gå på bekostning av kalvestellet. Et godt kalvestell basert på gode rutiner for råmjølksfôring og et tørt, reint og trekkfritt miljø er avgjørende for å oppnå god kalvevelferd. Ved oppstalling av dyr i kaldfjøs under våre breddegrader påligger det røkter et ekstra ansvar å ta hensyn til de utfordringene et slikt driftssystem kan gi.

6.2.3 Bakgrunn

Generelt tåler storfe mye kulde. Høgtytende mjølkekyr i god kondisjon har nedre kritiske temperatur (NKT) på under –40 ^{0}C i tørt og vindstilt vær, mens ungdyr av kjøttfe (150 kg) i god vekst under tørre og trekkfrie forhold har NKT på –15 ^{0}C (Webster, 1974). Nyfødte og unge kalver, derimot, er ikke veldig kuldetolerante. NKT for nyfødte kalver ligger på ca. +9 ^{0}C, forutsatt tørr og trekkfri oppstalling, mens den ved en måneds alder er ca. 0 ^{0}C (Webster 1978). Faktorer som trekk/vindhastighet, fuktighet, solstråling, alder, hold og pelstykkelse med mer har stor betydning for kuldetoleransen og dermed for NKT (Young 1981). Kuldestress blir kritisk for dyret først når dyret ikke klarer å øke forbrenninga tilstrekkelig,

slik at kroppstemperaturen synker (Færevik et al. 2006). Gjennom pilotprosjektet "Landbruksbygg i Arktis" (LiA) i er det utført to studier med fokus på kalvevelferd. Hovedmålet for LiA-prosjektet (2002-2008) er å sikre fremtidig landbruksproduksjon i Nord-Norge ved planlegging, bygging og etterprøving av bedre og billigere husløsninger basert på kaldfjøs for melkeproduksjon. Et delmål er at pilotbyggene skal sikre helse, miljø og velferd for både dyr og mennesker. Denne presentasjonen gir en evaluering av kalvevelferden i de åtte pilotbesetningene.

6.2.4 Studie 1: Velferd hos kalver i kaldfjøs

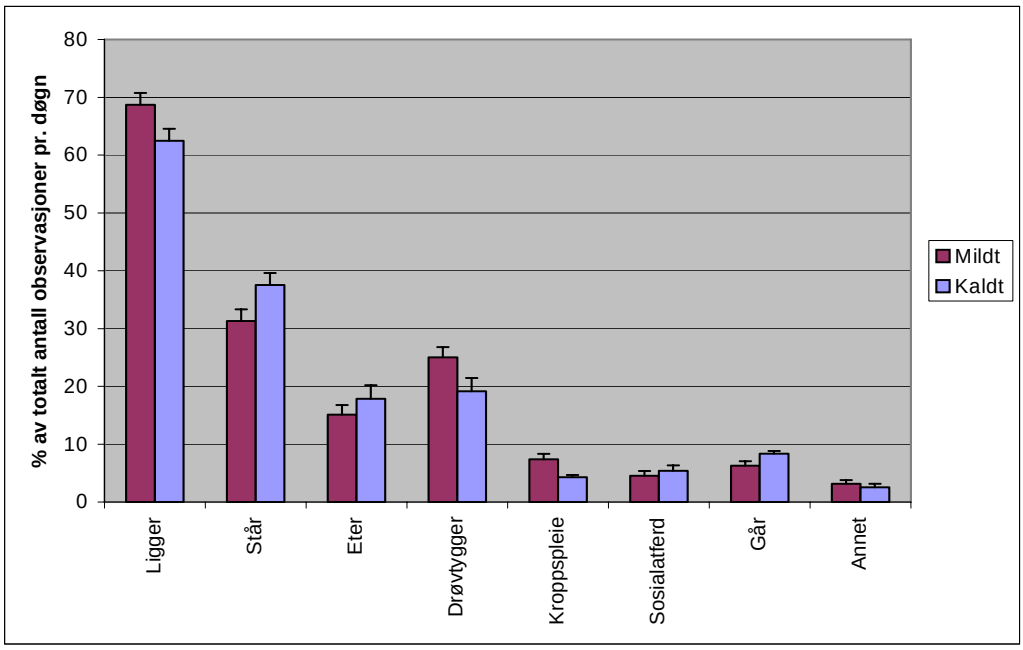
Materiale og metoder

Det er vanlig å holde de yngste kalvene noen måneder i isolert avdeling før de flyttes inn i kaldfjøsanlegget. Et av pilotbrukene som er lokalisert på Helgelandskysten har imidlertid kalvene i kaldfjøset fra første dag. Velferden hos kalvene i denne besetningen ble evaluert på grunnlag av atferdsparametere, produksjon og helsestatus. Studien foregikk under to klimakategorier: mildt vintervær (+5 ^{0}C til 0 ^{0}C) og kaldt vintervær (-5 ^{0}C til -10 ^{0}C). Spedkalvbingen (binge 1) for kalv fra 0-4 ukers alder hadde et "halvisolert" liggeareal med tre vegger og tak, samt plastforheng foran åpningen og varmelampe i taket. Kalver i aldersgruppen 1-6 måneder var oppstallet i gruppebinger med uisolert liggeareal (binge 2,3 4). Totalt var 15 kalver med i atferdsstudien, mens helsestatus ble vurdert på grunnlag av 55 kalver.

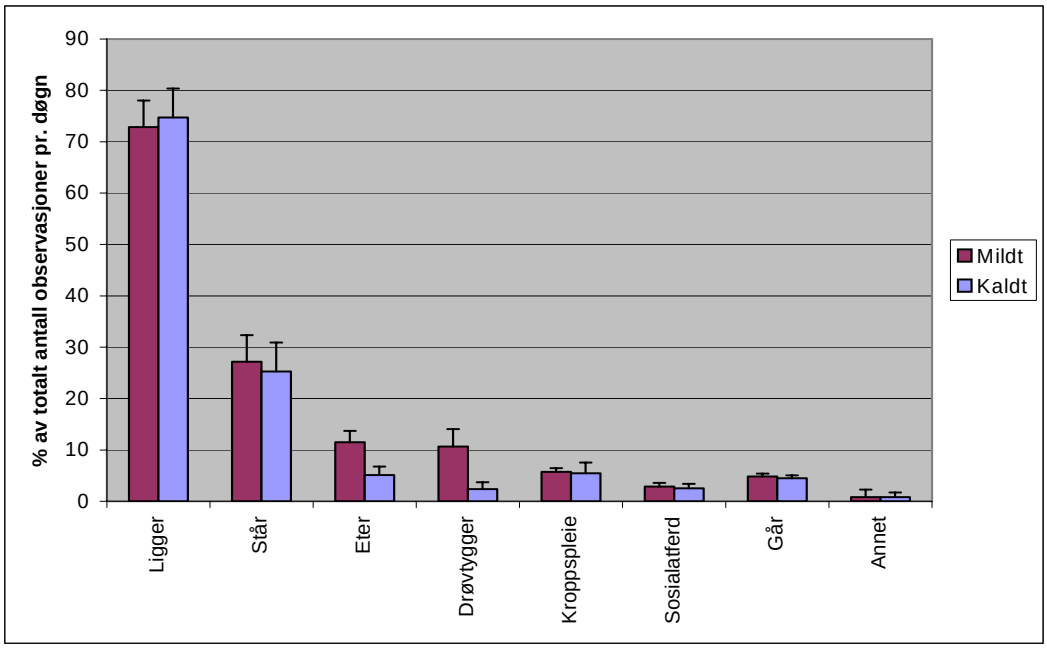
Resultater og diskusjon

Kalver på 1-6 måneders alder reagerte atferdsmessig på kulde ved å ligge mindre og stå mer ($P<0,001$, fig. 1) (Hansen og Jørgensen 2006). Kalvene gjorde heller ikke nytte av sosial termoregulering ved å ligge tettere i lag når det var kjølig. De eldste kalvene lå i overkant av 13 timer under de kaldeste periodene (fig. 3). Dette er ikke spesielt høy sett i forhold til hva som er rapportert i liknende forsøk (Bjerkan et al. 2004, Bak Jensen 2005), men det er heller ikke urovekkende lavt. For å karakterisere kort liggetid som et velferdsproblem hos kalver på et halvt års alder, må man sannsynligvis ned på snittider på under 12 timer i døgnet over lengre tid. Først da vil det gå ut over tilveksten og det totale søvnbehovet til kalven. Resultatene samsvarer godt med Færevik et al. (2005), som fant at liggetiden for voksne mjølkekyr i kaldfjøs gikk ned med synkende temperatur. Redusert liggetid under de kaldeste periodene indikerer at liggeunderlaget, i kombinasjon med fuktighet og kulde, ikke var noen optimal løsning. Til kalver i uisolerte fjøs bør det benyttes liggeunderlag med god isolasjonsevne, for eksempel porøse lettmatter eller rikelige mengder tørt strø, slik at r

eduksjonen i liggetid blir minst mulig.



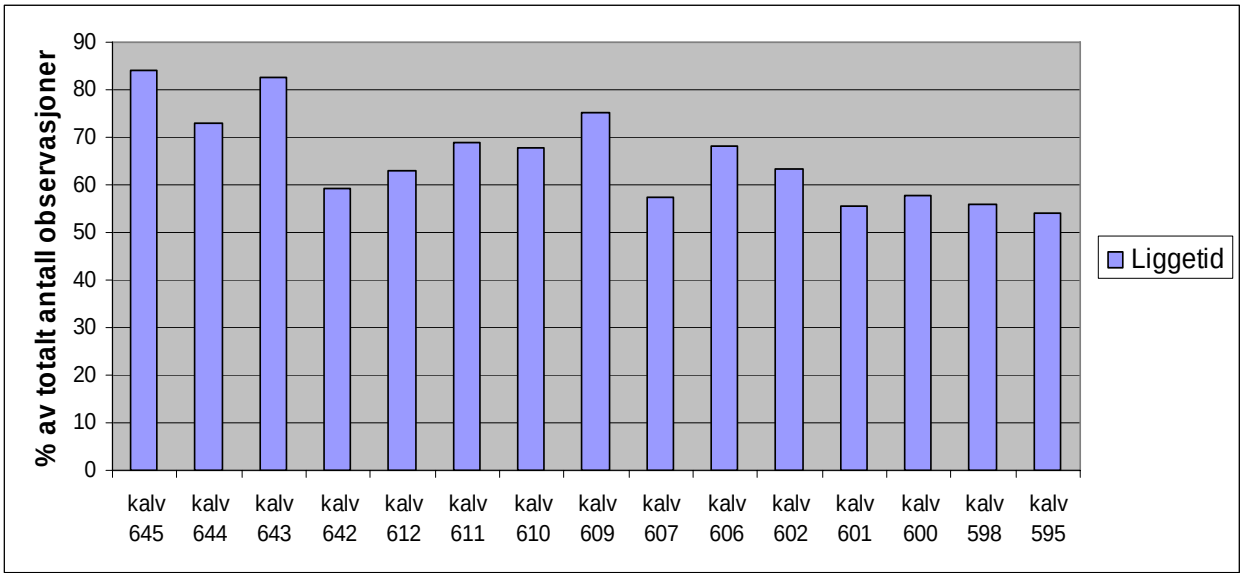
Figur 1. Tidsbudsjett på døgnbasis for kalvene i binge 2, 3 og 4 under mildt og kaldt vinterklima (means±SE).



Figur 2. Tidsbudsjett på døgnbasis for spedkalvene i binge 1 under mildt og kaldt vinterklima (means±SE).

Spedkalvene (0-4 ukers alder) oppholdt seg i den halvisolerte liggeavdelingen ekstra mye ($P<0,01$, fig. 2) og lå hyppigere inntil hverandre når det var kaldt ($P<0,05$). Det var imidlertid ingen forskjell mellom de to klimakategoriene mht. hvor mye de stod og lå (NS). En liggetid på nær 18 timer i døgnet i kuldeperiodene tyder på at liggeunderlaget i spedkalvbingen har gitt god liggekomfort, selv under de laveste temperaturene som ble registrert i denne studien

(fig. 3). Siden nyfødte kalver har høgere NKT enn eldre kalver, mener vi det er nødvendig å tilby spedkalver i uisolerte bygg på våre breddegrader en delvis isolert liggeavdeling. Alternativt må de ha en trekkfri liggeplass med rikelige mengder tørr halm som liggeunderlag.



Figur 3. Individuell liggetid pr. døgn ved kaldt klima. Yngste kalv med høgest ørenummer.

Det ble aldri registrert at noen av kalvene økte varmeproduksjonen ved å skjelve. Dette indikerer at kalvene hadde ytterligere strategier å sette inn dersom temperaturen skulle bli ennå lavere. Siden kuldeperiodene kun varte i kort tid må man se på endringene i atferdsmønsteret som en naturlig, atferdsmessig tilpasning til klimaet, uten at dette har påvirket kalvevelferden negativt på noen måte. Kulden i seg selv er ikke skadelig for kalvene dersom det ikke er svært kaldt, og så lave temperaturer får vi aldri på Helgelandskysten. Det er elementer i kombinasjon med kulde, som infeksiøse sykdommer, våt liggeplass, trekk med mer, som gjør at enkeltindivider kan bli utsatt for redusert dyrevelferd under lave temperaturer (Rawson et al. 1988).

Kalvene i denne besetningen hadde høy dødelighet (16 %), hovedsakelig grunnet leddbetennelser og mageinfeksjoner. Stor egeninnsats av bruker under byggeperioden gikk på bekostning av kalvestellet, bl.a. var råmjølkstildelingen i noen tilfeller mangelfull. Brukeren kan imidlertid vise til god helsestatus for kalvene nå etter at anleggsperioden er over. Slik sett var det driftingen av anlegget, og ikke kaldfjøset i seg selv, som bidro til høy kalvedødelighet. Resultatene bekrefter imidlertid at et godt kalvestell basert på gode rutiner for råmjølksfôring, et tørt, reint og trekkfritt miljø, samt et varmeisolerende liggeunderlag er ennå viktigere i kaldfjøs enn ellers for å sikre god kuldetoleranse og god dyrevelferd.

6.2.5 Studie 2: Generelle velferdsvurderinger av kalver og ungdyr i LiA-prosjektet

Materiale og metoder
Generelle velferdsvurderinger ble gjennomført i alle de åtte pilotbrukene vinteren 2007. Det ble benyttet standardiserte skjemaer utarbeidet av Bioforsk Økologisk i samarbeid med Veterinærhøgskolen og Tine sin rådgivingstjeneste (Henriksen et al. 2005). Disse tar for seg miljø- og innredningsmål, stell og stellrutiner, samt helse, atferd og produksjon. Velferden vurderes både hos kalver, ungdyr og voksne dyr og baseres hovedsakelig på enkeltdyrobservasjoner, samtidig som det også gis en generell velferdsvurdering på besetningsnivå. Evalueringen ble utført under ordinært fjøsstell av en veterinær fra Helsetjenesten for storfe og en Tine-rådgiver som begge hadde tidligere erfaringer med tilsvarende velferdsvurderinger. Gårdbrukeren var selv til stede og deltok aktivt i diskusjonen under besøket. Her presenteres foreløpige resultater fra kalv- og ungdyrevalueringen (Gjestvang, Tverås, Hansen og Henriksen, upubl.).

Resultater og diskusjon
Kalver
Kalver og ungdyr var den gruppen som oftest kom dårligst ut av byggeperioden ved ombygging/nybygging av gammelfjøset til kaldfjøs. Oppstallingsforholdene var preget av midlertidige løsninger, eller kalvene stod igjen i det gamle (isolerte) fjøset, som kunne være mørkt, trangt og fuktig. Kun ett av pilotbrukene hadde innlemmet kalvene i kaldfjøset fra fødselen av. Dette var en god løsning, bl.a. fordi det gir god oversikten over alle dyrene, samtidig som det er arbeidsbesparende å ha alle dyra i ett rom. I de aller kaldeste områdene i Norge anbefaler vi likevel å ha spedkalvene i isolert avdeling. Det var ikke revolusjonerende forandringer som skulle til for å bedre velferden, og de fleste av punktene nedenfor går på generelt kalvestell.

Anbefalinger og tiltak:
- Tidlig nok og tilstrekkelig med råmjølk.
- Pensle navlen med Jodosan (kjøpes på apotek) så snart som mulig etter fødsel for å hindre navlebetennelse.
- Kalvene bør oppstalles enkeltvis i kalvebokser de første 14 dagene for å redusere smittepresset. Deretter bør de stå i to-klima-binge med maksimum åtte kalver i bingen og en aldersforskjell på maksimum fire uker.
- Etter råmjølksperioden, bruk kjemisk syrnet helmjølk. Totalt sett er det mer lønnsomt å bruke helmjølk i stedet for mjølkeerstatning pga. risikoen for mage/tarm-forstyrrelser.
- Vær raus med mjølka de fire første ukene (7 l/dag). Tilvenn på grovfôr og kraftfôr allerede etter ei uke. Avvenn ved sju ukers alder etter en nedtrappingsperiode. Dette gir en kalv med god tilvekst som har drøvtyggerfunksjonen tidlig utviklet.
- Alle kalver skal ha et tørt og trekkfritt miljø (liggeareal: helningsgrad på 8-10 %, rikelig med strø, tre vegger og tak i tilknytning til liggearealet for å hindre trekk).
- Sjekk tilveksten på kalvene jevnlig.

Ungdyr
De fleste hadde også ungdyra oppstallet i det gamle, isolerte fjøset. Anbefalinger og tiltak:

- Øke belysningen på dagtid (viktig for normal brunstutvikling).
- Sikre tilstrekkelig vatntilførsel (antall vatnkilder og vatntrykk) med god nok hygiene.
- Klippe dyra hver høst for å hindre tilgrising og utøy.
- Tilstrebe luftfuktighet lavere enn 70 %.
- Skjerme for trekk

Menneske/dyr-forhold
Generelt var dyra rolige og tillitsfulle. Kun i enkelte av besetningene ble det registrert noe skye kalver og ungdyr overfor fremmede, noe som kan skape problemer dersom dyra må håndteres av fremmede. Sannsynligvis skyldes dette at det daglige røktet i disse besetningene ble utført av få personer. Anbefalt tiltak: Bruke mer tid, spesielt på kalv og ungdyr, og sørge for at dyra får positive erfaringer med ulike personer.

6.2.6 Konklusjon – helhetsvurdering studie 1 og 2

I alle besetningene var det forhold som ut fra dyrevelferdsmessige hensyn kunne vært gjort bedre. På disse pilotbrukene, som i de fleste andre fjøs, er det røkteren som er den viktigste faktor med hensyn til å sikre god dyrevelferd. Et godt kalvestell basert på gode rutiner for råmjølksfôring og et tørt, reint og trekkfritt miljø er av avgjørende betydning for å sikre god kalvevelferd. Dersom kalvene står oppstallet i kaldfjøs må røkter ta hensyn til de ekstra utfordringene et slikt driftssystem kan gi.

6.2.7 Litteratur

Bak Jensen, M., L. Juul Pedersen and L. Munksgaard. 2005. The effect of reward duration on demand functions for rest in dairy heifers and lying requirements as measured by demand functions. Appl. Anim. Behav. Sci. 90: 207-217.

Bjerkan, G., K. Nybø og G. Næss. 2004. Prosjektrapport "Kaldfjøs for kalv". Oppstalling av kalver i iglo. Et fullskala forsøk ved Mære landbruksskole. Mære landbruksskole, 14 ss.

Færevik, G., E. Simensen, A. Aulie and K.E. Bøe. 2005. Melkeku i uisolert fjøs – resultater fra feltforsøk i Pasvik. UMB-rapport 02/2005, 24 ss.

Færevik, G., K.E. Bøe, I.L. Andersen and E. Simensen. 2006. Hold av melkeku og kalver i uisolerte bygninger – en oversikt. Norsk veterinær tidsskrift 118: 77-83.

Hansen, I. og E. Jørgensen. 2006. Velferd hos kalver i kaldfjøs. Bioforsk Rapport, Vol. 1 Nr. 67, 31 ss.

Henriksen, B., L. Grøva and C. Kielland. 2005. Securing animal health and welfare on organic dairy farms in Norway. In: Assessment of Animal Welfare at Farm and Group Level. Proceedings from the 3rd International Workshop, WAFL-05, Sept. 22nd-24th 2005, Vienna, p. 69.

Rawson, R.E., H.E. Dziuk, A.L. Good, J.F. Anderson, D.W. Bates, G.R. Ruth and R.C. Serfass. 1988. Health and physiology of newborn calves housed in severe cold. Livestock Environment III. Proc. third international livestock environment symposium, April 25-27, 1988, Toronto, Canada. Am. Soc. Agric. Eng., E Publication 1-88, 365-368.

Webster, A.J.F. 1974. Heat loss from cattle with particular emphasis on cold. Monteith, J.L. & Mount L.E. (eds.). Heat loss from animals and man: assessment and control. London, Butterworth, 205-223.
Webster, A.J.F., J.G. Gordon and R. McGregor. 1978. The cold tolerance of beef and dairy type calves in the first weeks of life. Anim. Prod. 26: 85-92.
Young, B.A. 1981. Cold stress as it affects animal production. J. Anim. Sci. 52: (1) 154-163.

6.3 Dehorning of calves at 2, 4 or 6 week of age.

Kolbjørn Nybø, Nortura, Norway
Hanne Solheim Hansen,
Nord-Trøndelag University College, Norway

6.3.1 Abstract

lder age. This delay in dehorning may be due to several practicalities and may also be due to farmers feeling that calves are too small to endure dehorning. Therefore we conducted the present study to find any optimal age for dehorning. A total of 18 calves were divided into 3 groups of 6 calves. Group A was dehorned during their 2nd, group B during their 4th and group C during their 6th week of life. Live weights of all calves were measured from 7 to 46 days of age. Tissue damage was registered 3 times on each animal until 11 days after dehorning. Calves were dehorned at 45 kg, 48 kg, and 54 kg, in the groups A, B and C, respectively. Comparison of the live weight gain in the same calves the week before dehorning and the week following dehorning showed no significant difference. Also the live weight gain the week following the dehorning was not significantly different between the dehorned calves and control calves. DDehorning of cattle is carried out to reduce the risk of injury to herders and other animals, and dehorning of calves is a common routine in dairy and beef herds. According to regulations in Norway dehorning must be carried out before the calf reaches 7 weeks of age. In spite of this regulation a considerable number of calves are dehorned at ouring the 11 days after dehorning 4 of the 18 calves had complications (swelling, bleeding or infections) related to the tissue damage in and around the dehorning spot. The results showed that dehorning between 2 and 6 weeks of age made no difference on live weight gain in the calves.

6.3.2 Sammendrag

Avhorning av kalv gjøres rutinemessig i alle storfebesetninger for å unngå skade på røkter og andre dyr i flokken. I henhold til forskrifter kan kalv avhornes når de er under 6 uker gamle, likevel viser undersøkelser at mange kalver avhornes når de er eldre. Det er sannsynlig mange praktiske grunner til at det blir slik. En annen årsak kan være at gårdbrukere synes kalvene er for små til å tåle avhorning og derfor utsetter inngrepet. Denne studien ble gjennomført for undersøk effekten av avhorning ved 2, 4 eller 6 ukers alder på tilvekst og sårkomplikasjoner. Tre grupper med 6 kalver i hver gruppe ble avhornet ved 2 (gruppe A), 4 (gruppe B) eller 6 ukers alder (gruppe C). Alle kalvene ble veid 3 ganger i uken fra 7-46 dages alder. Sårheling og komplikasjoner ble registrert 3 ganger på hver kalv frem til 11 dager etter avhorning. Kalvene veide 45 kg, 48 kg og 54 kg ved avhorning i henholdsvis gruppe A, B og C. Det var ingen signifikant forskjell i tilvekst når vi sammenlignet tilvekst hos enkeltindividene uken før avhorning og den første uken etter avhorning. Dette var uavhengig av alder ved avhorning. Det var heller ikke forskjell i tilvekst hos avhornet kalver og kontroll kalver (ikke avhornet) uken etter avhorning. I løpet av de 11 dagene sårregistreringene ble gjort hadde 4 av 18 kalver sårkomplikasjoner i form av hevelse, blødning eller infeksjon i eller rundt avhorningssåret.

Resultatene viste at det ikke var forskjell i tilvekst uansett når kalven avhornes mellom uke 2 og uke 6.

6.3.3 Introduction

Dehorning of calves is a common routine in dairy and beef herds in Norway and other countries. Dehorning is carried out to reduce the risk of injury to herders and other animals in the herd. There is good evidence that the procedure used to dehorning calves is painful, regardless of what method that has been used *(Laden et al, 1985; Petrie et al 1995; Grøndahl-Nielsen et al, 1999; Faulkner et al, 2000)*. However, the benefit to other animals and herders is regarded to outweigh the disadvantages of pain involved in the dehorning. Thus dehorning is a part of both dairy and beef production in most countries.

Dehorning is usually performed on calves. A relevant topic is to dehorn calves when the procedure causes less negative consequences. The horn buds should easily be identified and the calf should be old enough to bear up under strain. In Norway dehorning has to be performed before the age of 6 weeks according to governmental regulations *(Forskrift om å fjerne horn på dyr. 1976)*. In spite of these regulations data from the Norwegian Dairy Health Monitor system indicates that 24 % of the calves with hornbuds are dehorned at an age older than 6 weeks *(Østerås – personal communication)*.

The procedures used to dehorn calves are hot-iron, hot-air gun and caustic paste. In Norway dehorning is carried out by veterinaries using hot-iron or hot-air gun method including the use of local anaesthetics and long acting analgethics (*Haga et al. 2007*). Complications followed dehorning are bleeding, swelling and/or infections in the tissue wounds *(Haga et al.2007,Fjerdingby et al. 2003)*. However, field reports from vets demonstrate little complications after dehorning *(Haga et al. 2007).* Reduced feed intake and live weight gain may also be implications, and field studies of those issues show varying results. Previous studies conducted in Norway have indicated that weight gain was reduced the first week following dehorning *(Hansen et al. 2006)*. Another study showed that live weight gain was not affected in calves dehorned at 8 weeks of age *(Laden et al. 1985).*

Because of pain and tissue damage caused by the dehorning, other stressors like weaning, changing group or housing should not be done at the same time. In Norwegian dairy- and cattle herds it is important to know the effect of dehorning on growth rate to plan the best dehorning procedure. The purpose of the present study was thus to describe the effect of dehorning at different ages on weight gain and the development of complications after dehorning.

6.3.4 Materials and methods.

The study was conducted at Mære Agricultural School, Nord-Trøndelag, Norway from Mars to May, 2006. The calves were of the dual purpose breed Norwegian Red Cattle. Twelve of the calves were born at the agricultural school, while six calves were bought from neighbour farms at the age of seven days or younger. The calves were allocated to three groups, A, B or C according to the age at which the dehorning was planed, during their 2^{nd}, 4^{th} or 6^{th} week of life (Table 1). Each week 3 or 6 calves were included in the experiment and a similar number of calves (one or two) were allocated to each group.

Table 1. Number of calves, planed and actual age at dehorning.

Group	Planed age at dehorning	Actual age at dehorning, days	Number of calves
A	2nd week of life	7-11	6
B	4th week of life	21-25	6
C	6th week of life	35-39	6

The calves were housed in the barn until 2 to 3 weeks of age, and then moved to the outdoor calf-housing for the rest of the study period. Thus groups A calves were dehorned while inside and moved to the outdoor housing facility 1 week after dehorning. Group B and C calves were dehorned while housed in the our-door facility. Feeding was similar while housed indoor as in the out-door facility. Calves were weaned at 10 weeks of age after a slow decrease in daily milk allowance from week 8.

Before dehorning a sedative and local anaesthetic were administered. All calves were dehorned by the same veterinary using a hot-air gun method. The hot-air gun was applied in a two-step procedure *(Fjerdingby et al. 2003).*

Live weights of the calves were measured twice a week at the same time each Monday and Thursday, using a digital platform weight (±0,5 kg). All calves were either weighed at birth or/and when purchased. Thereafter from 7 until 46 days of age. Calves from the C-group served as controls for the A- and B-group. Calves from the A-group served as controls for the C-group. Average live weight at dehorning and 7 days after dehorning were compared using a pair-wise t-test (SPSS). Average daily gain during a 7 day period before and a 7 day period after dehorning were also compared using a pair-wise t-test (SPSS).

Complications after dehorning as bleeding, swelling or infection were controlled 3 to 4, 6 to 7 and 10 to 11 days after dehorning.

6.3.5 Results and Discussion

The live weights of calves at dehorning in groups A, B and C were 45 kg, 48 kg and 54 kg, respectively (Fig 1). Average live weights increased during the first week after dehorning independent of age at dehorning. The live weight increase from dehorning and 7 days later was not significant for any of the groups, due to a fair amount of variation between the animals in each group. The average daily gain during the entire study period from 7 days of age to 46 days of age were 0,380 kg (std = 0,066), 0,400 kg (std = 0,104) and 0,390 (std = 0,074) kg / day for the A- B- and C-calves, respectively.

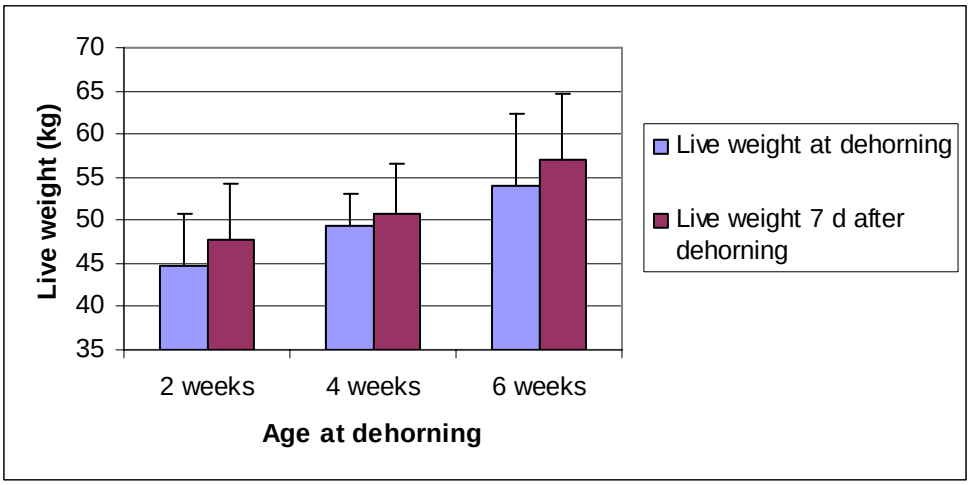


Fig 1. Average live weights of calves at dehorning and 7 days after dehorning. Calves in group A, B and C were dehorned during their 2nd, 4th and 6th week of life, respectively. A total of 6 calves in each group.

Around dehorning, average live weight gain was between 400 g/d and 500 g/d for all groups (Fig 2). This is slightly more than the live weight gain during the entire study. The live weight gain was reduced during the 7 days after dehorning for group A and C while it was slightly increased for group B. However, the live weight gain was not significantly different during seven days before dehorning compared with seven days after dehorning.

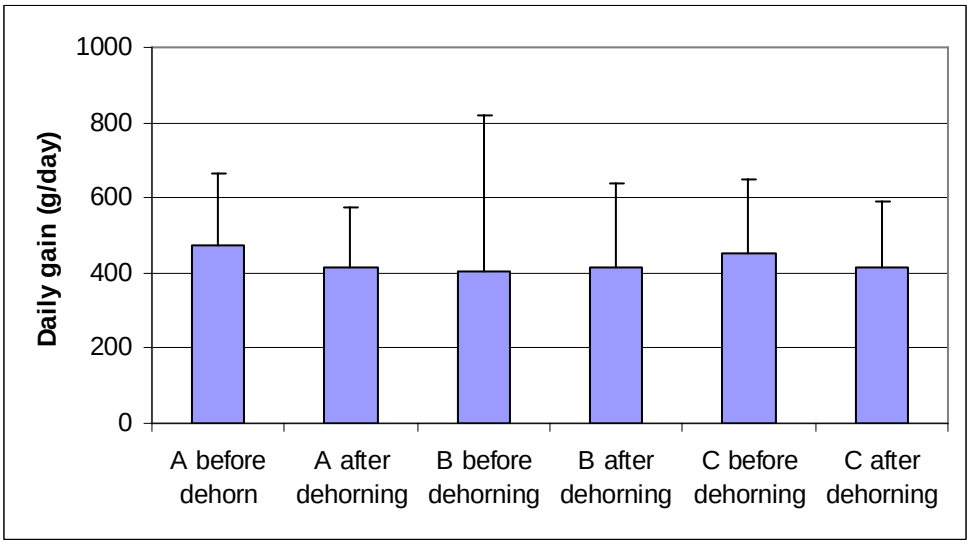


Fig 2. Average daily weight gain during a period of seven days before and seven days after dehorning. A total of 6 calves in each group.

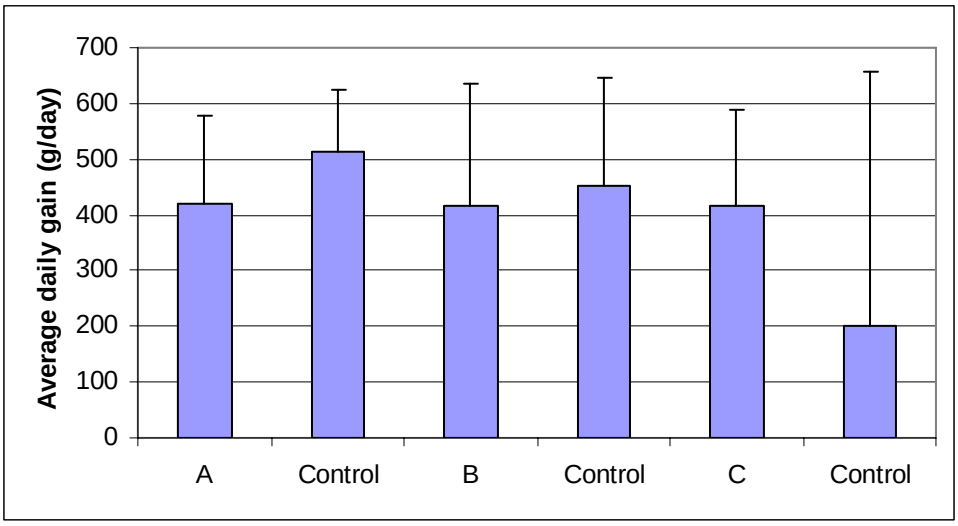


Fig 3: Daily weight gain during seven days after dehorning. A,B and C calves compared with controls at same age, but not dehorned

There was no significant differences in weight gain between the dehorned calves at different ages and their controls (Fig 3).

The live weight gain of calves in the present study was not affected by the dehorning, irrespective of age at dehorning. Thus, planning of age at dehorning seems to be of minor significance in the interval from 2 to 6 weeks. For practical purpose planning of dehorning should at first consider to avoid changes in managemental factors such as changing of gropu and housing and feeding at the same time as dehorning.

To minimalize the eventually effect of differences in environmental and managemental conditions this trail was performed with one A-, B- and C-calf in each group. Measured weight seemed to vary a lot from time to time. The point of measures of weight was done at the same point of time during the study. In spite of this, the time of point for the calves feedintake and defecation varies, and will naturally influence weight. One case of disease was registered during the trail. This calf, belonging to the C-category got treatment against pneumonia. Despite this condition the weight gain for this calf was higher in this period compared with the average for his group. During the study there were low efficient temperatures in a period from mars and halfway into april. Studies with a greater number of calves associated with daily measures of weight should be carried out to obtain more certain data.

Table 2. Number of calves with bleeding, swelling or infections in the tissue at and around the dehorning spot.

	Time for registration after dehorning		
Group	3 to 4 days	6 to 7 days	10 to 11 days
A	2	1	2
B	0	0	2
C	0	0	0

In this study 4 of 18 calves showed complications in the tissue and around the dehorning spot. Later follow-up studies at Mære Landbruksskole showed that such complications were more frequent later than 10 days after dehorning. Consulting literature we found that this problem is

not very much a topic of investigation. These studies indicates more studies of this topic should be carried out.

6.3.6 Literature

Faulkner, P.M, and D.M. Weary. 2000. Reducing pain after dehorning in dairy calves. J Dairy Sci 83:2037-2041.

Fjerdingby, N., and S Waage. 2003. Sammenligning av to metoder for avhorning av kalv. Norsk Vet Tids 115:7-15

Forskrift om å fjerne horn på dyr. Forskrift av 20 november 1976, nr. 1. Oslo 1976

Grøndahl-Nielsen, C., H.B. Simonsen, J. Damkjer Lund, and H. Hesselholt. 1999. ehavioural and cardiac responses in young calves undergoing dehorning without and with the use of sedation and analgesia. Vet. J. 158:14-20.

Haga, H.A., J.M. Arnemo, T. Fjeldaas, N. Fjerdingby, B. Ranheim, and T. Ådnøy. 2007. Avhorning og kastrering av kalv og kje – anbefalte metoder og dyrevelferdsmessige aspekter. Norsk Vet Tids 119:155-163.

Hansen, H.S, Næss, G., Moum, D. O., Bjerkan, G., Stuberg, H., Nybø, K., Tverås, B. 2006. Utendørs oppdrett av kalv i iglo-system. Kunnskap til begjær – ut utvalg nordtrøndersk forskning. M. Stene (red) Høgskolen i Nord-Trøndelag

Laden, S.A, J.E. Wohlt, P.K. Zajac, and R.V. Carsina. 1989. Effects of stress from electrical dehorning on feed intake, growth and blood constituents of Holstein heifer calves. J.Dairy Sci. 68: 3062-3066.

Petrie, N.J., D.J. Mellor, K.J. Stafford, , R.A. Bruce, and R.N. Ward. 1996. Cortisol responses of calves to two methods of disbudding used with or without local anaesthetic. N.Z. Vet. J. 44:9-14.