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Health and growth of Finnish beef calves and the relation to acute phase response

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ABSTRACT

Healthy, thriving calves are essential for beef calf production. We studied the health status and factors associated with the growth of beef calves in six cow-calf herds during the first month of the calves' lives and at weaning age (200 days).

The six herds were visited three times, when calves were approximately 3 days, 16 days and 30 days of age. On each visit calves (n=37) were clinically examined, weighed or measured, blood samples were collected, faecal samples obtained and deep nasopharyngeal swabs were taken. Each blood sample was analysed for acute phase proteins (haptoglobin, serum amyloid-A, fibrinogen), total proteins and albumin, the faecal sample for intestinal tract pathogens (rotavirus, bovine coronavirus, enterotoxigenic *Escherichia coli* and *Salmonella*, oocysts of *Eimeria* coccidia and *Cryptosporidium*, and nematode eggs), and the nasopharyngeal swab for respiratory tract pathogens (bovine coronavirus (BCV), respiratory syncytial virus (RSV), bacteria and mycoplasma).

Clinical diagnosis of respiratory tract disease, diarrhoea or umbilical disease was set at 15.0% for all the three consecutive examinations combined (n=107), but only few pathogens were detected from the samples. The increased levels of acute phase proteins were neither associated with any of the diseases nor with the pathogens. Random intercept linear models were used to explore factors affecting early (3–30 days) and long-term (3–200 days) growth, showing that calves with elevated serum amyloid-A concentrations at the age of 16 days had lower long-term growth. Increased albumin concentration at 30 days of age and higher parity of the dam increased early-term growth. The lack of association between a disease and the acute phase protein may stem from the low disease prevalence in the beef calves examined. The measurement of acute phase proteins of a young calf can help identify animals with possible future growth deficiencies, although the mechanisms through which the association between acute phase proteins and growth has yet to be explained.

1. Introduction

A good growth rate of beef calves is essential for an efficient beef production. Various factors contributing for the differences of growth among individuals have been revealed over the years, including gender (Krupa et al., 2005; Toušová et al., 2014) and breed (Lundborg et al., 2003; Krupa et al., 2005) to diseases (Windeyer et al., 2014). Also various management practices, e.g. feeding method of colostrum and group size of the calves in group pens in dairy calves are associated with the growth of the calves (Brickell et al., 2009).

The dams of the beef calves have an important role on the health and subsequently growth of the calves, as the dams are the main source of nutrition and care for the beef calves. However, at least the age and breed (Krupa et al., 2005) or parity of the dam (Lundborg et al., 2003; Murray et al., 2014) have shown associations with the average daily gain of beef or dairy calves. More direct association was recorded for getting adequate amount of colostrum, lower diseases incidence and daily weight gain (Dewell et al., 2006; Furman-Fratczak et al., 2011). Diseases reduce growth rate (Thompson et al., 2006; Windeyer et al., 2014), mostly by reducing feed intake and increasing muscle catabolism (Gabay and Kushner, 1999). In addition, cytokines released in the inflammatory process directly reduce appetite (Borghetti et al., 2009).

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Calves are thought to compensate the cessations of growth, but compensatory growth has been mostly observed after experimental feed restriction (Hornick et al., 2000); the ability of the calves to compensate after recovering from a disease is less studied.

Acute phase proteins, synthesized by the liver at the onset of the inflammation are valid markers of inflammatory diseases (Petersen et al., 2004). The major positive acute phase proteins in cattle are haptoglobin (Hp), serum amyloid-A (SAA) and fibrinogen (Fb) (Humblet et al., 2004; Nikunen et al., 2007). Albumin is a negative acute phase protein, whose concentration decreases during inflammation (Jacobsen et al., 2004; Petersen et al., 2004). Decreased albumin concentrations have been detected at least with uterine infections (Schneider et al., 2013) and experimentally induced acute phase response (Jacobsen et al., 2004). Acute phase proteins have also been used as prognostic markers or assessing severity of diseases (Horadagoda et al., 1999; Humblet et al., 2004; Schneider et al., 2013).

The aim of this study was to explore the health of beef calves, follow growth and examine factors associated with diseases, growth and acute phase response before weaning.

2. Material and methods

Calves from six herds were included in the study. Convenience sampling was done from farms located in southern and south-western Finland and those participating in the Beef Cattle Development Project of the HKScan slaughterhouse. Inclusion criteria were having a compact calving season in the spring and providing means and facilities for weighing the calves. All herds were free from bovine viral diarrhoea virus (BVDV) and were not subject to any vaccination protocol. Farms had typical Finnish beef calf herds where during the winter and spring the animals were kept in uninsulated, spacious, naturally ventilated free stall barns with sloped floors and straw bedding. Cows had free lying space but on one farm lying stalls were used. Cows had ad libitum feeding on silage. Dams and calves grazed starting from mid-May and the bull was kept within the herd to breed. Dams usually calve inside the barn, but some also on the pasture depending on the time of serving. The mean cow number on the farms was 58, ranging from 39 to 78 dams.

On each farm, 5–8 calves born within 2–5 days were included, resulting in 37 calves from 6 farms. The calves were either Herefords (farms A, B and C; n=19) or Charolais (farms D, E and F; n=18) breed. 57% of the calves were heifers, 30% Herefords and 27% Charolais heifers.

Calves were born in March and April 2009 and farm visits were scheduled to begin when the farm had as many as possible calves born within 3–4 days. The farms were visited at approximately two week intervals by the one or two veterinarians working in the research project, resulting in visits when the calves were 3.3 ± 1.1 days, 16.4 ± 1.4 days and 30.2 ± 1.2 days old. At each visit calves were weighed (or measured with weight tape on one farm), clinically examined, and blood samples, faecal samples and deep nasopharyngeal swabs were obtained. Blood samples were obtained with minimal restraint of the calves to reduce stress, and the dams had visual access to blood sampling of the calves, from behind the fence. The clinical examination included auscultation of the heart and lungs, measuring the heart rate, respiratory rate and body temperature, palpation of the umbilical stalk and palpation of the stifle, hock, carpal and fetlock joints, and visual assessment of faecal consistence. Heart rate, respiratory rate and body temperature were recorded as measured and other findings from clinical examination were scored as in Table 1. Scores of 2 for umbilicus, faeces or joints were considered to represent clinical diseases. Calves with increased intensity of respiratory sounds (score 2) were defined as suffering from respiratory tract disease, if they simultaneously had respiratory rates≥40/min and body temperatures≥39.5 °C. The weaning weights at approximately 200 days of age were from the production records of Faba, a national cattle breeding cooperative organisation.

Table 1
Scoring in the clinical examination of the beef calves.

	Umbilicus	Respiratory sounds	Faeces	Joints
0	Normal	Normal	Normal	Normal
1	Swelling/minor change	Slightly increased	Pasty-like	Some swelling in the joint
2	Tender, warm, enlarged umbilical stalk	Clearly increased or crackles	Watery faeces	Arthritis (warm, swollen, tender)
3	Hernia			

The body condition score of the dams was evaluated on a 1–5 scale with 0.25 intervals (1=emaciated, 2=thin, 3=average, 4=heavy, 5=fat) on the first and third visit and the parity of the dam was recorded.

2.1. Collection and analysis of the blood, faecal and deep nasotracheal swab samples

Blood samples were collected by venapuncture from the jugular vein into EDTA and plain serum tubes (BD Vacutainer, New Jersey, USA). The samples were analysed for complete blood count and total protein, albumin, Fb, Hp and SAA concentration. Globulin concentration was calculated as globulins = total protein - albumin. The complete blood count analysis was performed using an automatic system (Coulter-Counter Model T850, Coulter Electronics, Luton UK), as well as the total protein and albumin measurements (KONE Pro, version 5.4, Konelab, Finland). Fibrinogen concentration was determined with the heat precipitation method (Millar et al., 1971). For the haptoglobin measurements, a modified haptoglobin-haemoglobin binding method was used (Makimura and Suzuki, 1982), where o-dianisidine was substituted by tetramethylbenzidine as a chromogen (Alsemgeest et al., 1994). SAA measurements were performed by sandwich ELISA according to manufacturer's instructions (Phase SAA assay, Tridelta Development Ltd., Maynooth, Co. Kildare, Ireland).

Deep nasopharyngeal swabs were collected using a 27 cm long sterile, guarded swab Dryswab™ (Medical Wire Equipment Ltd., Corsham, England) (DeRosa et al., 2000). From the deep nasopharyngeal swabs, anaerobic and aerobic bacterial culturing was performed and *Ureaplasma diversum*, *Mycoplasma bovis*, respiratory syncytial virus (RSV) and bovine coronavirus (BCV) were examined as described by Autio et al. (2007).

Faecal samples were collected from the rectum into plastic bags and analysed for salmonella, *Escherichia coli* (ETEC), rotavirus, coronavirus, *Cryptosporidium* spp., parasite egg counts and *Eimeria* spp. oocyst count. Salmonella culture was made according to ISO 6579:2002 and virulence factors for *E. coli*/ETEC (F5, F41, ST1) were detected with PCR described by Wieler and Bauerfeind (2003). Presence of rotavirus and bovine coronavirus was detected using a commercial ELISA kit (Duo Digestive Kit, Bio-X, Jemelle, Belgium). Parasite egg count and *Eimeria* spp. oocyst count were performed using the conventional McMaster's method. *Cryptosporidium* spp. was detected using Ziehl Neelsen staining and *Cryptosporidium* spp. positive samples were examined with a restriction length polymorphism PCR for species identification (Feng et al., 2007).

2.2. Statistical methods

Factors related to the serum proteins (albumin and globulins) and APP (Hp, SAA and Fb) concentrations during the neonatal period of beef calves were studied using random intercepts linear models. In those models protein concentrations were included as outcome variables and farm and calves as random factors. First order autoregressive covariance structure was included in the model to account for repeated