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A phenotypical approach to the effects of production traits, parturition, puerperium and body condition on commencement of luteal activity in high yielding dairy cows

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ABSTRACT

The interval from calving to commencement of luteal activity (CLA) was determined by progesterone measurements from milk samples obtained once a week until the 14th week post-partum in 513 German Holstein cows in first to third parity. Milk samples were analyzed by an "on-farm" device (eProCheck®, Minitüb, Germany) and simultaneously by RIA. The objective of this study was to examine the effect of milk yield, protein content and body condition of a cow on the CLA post-partum. Milk progesterone concentrations of "on-farm" measurements correlated with measurements done by the RIA-method significantly ($r = 0.72$; $P < 0.001$). Within the analyzed herd the interval from calving until the first rise of progesterone averaged 5.6 ± 2.4 weeks. The 100-days milk yield was not associated with CLA. Cows with a milk protein content at 1st milk recording of ≤3.5% revealed first luteal activity 1.3 ± 0.3 weeks later than cows that had a content of >3.75% protein ($P < 0.01$). Furthermore cows with assisted calving or dystocia presented significantly later CLA than cows which required no help during the calving process ($P < 0.05$). The change in back fat thickness from 1st to 2nd milk recording had a significant influence on CLA ($P < 0.05$). In conclusion the phenotypic impact of milk yield on fertility cannot be confirmed regarding to CLA. The negative energy balance after calving, caused by the high milk yields, is more detrimental for the cyclical activity as was shown by the parameters milk protein content and change in BFT.

1. Introduction

Based on breeding and improved husbandry conditions milk yield increased in the German Holstein population from 7869 kg in 2000 to 9.063 kg in 2011 (ADR, 2012). In contrast to this, fertility of dairy cows has shown a negative tendency.

Whereas the calving interval was around 396 days in 2000, the mean value in 2010 amounted to 413 days (ADR, 2012). Therefore it is a crucial aim of cattle breeding to characterize significant reproductive performances to find suitable traits to evaluate fertility. More frequently used reproductive traits are age at first calving, calving

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interval, days open, number of inseminations and insemination interval etc. However these traits reflect also the influence of management factors. Different references (Forster et al., 2007; Stevenson et al., 2007; Sheldon and Dobson, 2004) discuss ovarian, behavioral or uterine traits to evaluate more accurate the phenotypical reproductive status of cows. The observed traits should have high heritabilities which could be used for genetic selection. Such a parameter could be the "commencement of luteal activity" (CLA). Estimates of heritability for CLA range from 14 to 28 percent (Darwash et al., 1997; Veerkamp et al., 1998; Royal et al., 2002). Consequently it is four to five times higher than fertility indices which have been introduced to the estimation of recent breeding value. Scientific studies discuss milk yield, protein content and body condition as crucial parameters on the CLA (Patton et al., 2007; Wathes et al., 2007; Windig et al., 2008). The major aim of this study was to characterize the effect of milk yield, protein content and body condition on the development of CLA. Furthermore the repeatability of CLA in the next lactation should be considered. Additionally the influence of parturition and the occurrence of endometritis are of substantial interest.

2. Materials and method

2.1. Animals and sample collection

From November 2009 to December 2011 milk samples were taken from German Holstein cows for progesterone (P4) measurement. These cows were kept on a dairy farm with free-stall housing in Mecklenburg-Western Pomerania, Germany. Starting from the 3rd week until the 14th week post-partum premilking samples from 513 cows of the first up to the third lactation were taken once a week. A total amount of 678 lactations were analyzed. In 2011 the herd reached a mean performance of 10,602 kg milk per cow containing 4.07% fat and 3.39% protein.

To analyze the impact of performance the 100-days milk yield was used. The milk yield for each cow was measured daily by a milkmeter and all records for every lactation were summarized to the 100-days milk yield. The milk protein content was determined on the basis of data from the first milk recording which were standardized on the day of lactation by linear regression. Furthermore, diagnosis and treatment data, which concern endometritis were extracted from the herd management software (AGROCOM SUPERKUH, CLAAS Agrosystems, Germany) and also included into the evaluation.

To estimate the influence of body condition on CLA the change in Body-Condition-Score (BCS) and back fat thickness (BFT) from first to second milk recording were used. These official milk records were performed once a month by the LKV Mecklenburg-Vorpommern (Guestrow, Germany) to evaluate the herd within the breeding program of the breeding organization. The average first and second official milk records were on day 23 and day 57 respectively. This represents the most sensitive time at the beginning of the lactation. BCS was assessed by using a 1–5 scale where a score of 1 indicated a skinny condition and a score of 5 an obese condition (Edmonson et al., 1989). BFT was measured by ultrasound examination at the sacral region as described by Staufenbiel (1992). A portable ultrasound generator with a linear transducer (Proxima Pavo, Proxima Medical Systems; Germany) and a frequency of 6.0 MHz was applied. Both body condition parameters were determined once a month by the same person at every milk recording. The evaluation of the parturition was included in the study. It was distinguished between spontaneously delivered calves and those delivered by mild to severe extractions or cesarean section respectively. Additionally these observations were accompanied by the control of the puerperium of the cows. The involution of the uterus and the presence of pus in the vagina were used for diagnosis of endometritis (Sheldon and Dobson, 2004).

2.2. Progesterone analysis

In total 7662 milk samples were analyzed by an "on-farm" device (eProCheck®, Minitüb, Germany) which is based on an ELISA method. Simultaneously 7650 milk samples were analyzed by using RIA as described in Blödow et al. (1988). The threshold value for CLA was determined as the first week post-partum where the P4 concentration exceeded 5 ng/ml milk. The intra-assay and inter-assay coefficients of variation ranged from 4.5 to 9.5 and 9.7 to 15.6 respectively for the "on-farm" ELISA. The intra-assay and inter-assay coefficients of variation were 8.0 and 9.6, respectively, for the RIA. The limit of sensitivity for RIA, using a 50 μl milk sample, was 8 pg/ml.

2.3. Statistical analysis

All calculations were carried out using SAS version 9.2 (SAS Institute, 2008). Evaluation of the factors associated with CLA was performed by the MIXED procedure of SAS. The model included fixed effects on milk yield, protein content, parity, calving ease and endometritis as well as a combined year–season effect. A second model included the change in BFT respectively BCS from first to second milk recording and also treatments because of endometritis and year–season as fixed effects. The models were adjusted for multiple lactations within the same cow by use of a compound symmetry covariance structure. Multiple comparison adjustment for the pairwise difference in least square means was performed by using the Tukey–Kramer option in SAS. Statistical significance was considered at P-value <0.05.

3. Results

The results for P4 concentrations of both methods are presented in Table 1. The difference in means between RIA- and "on-farm"-progesterone concentrations in premilking amounted to 1.5 ng/ml. The milk progesterone concentrations of "on-farm" measurements correlated with measurements done by the RIA-method significantly ($r = 0.72$; $P < 0.001$) (Fig. 1). Within the analyzed herd the interval from calving until the first rise of progesterone averaged at 5.6 ± 2.4 weeks. The repeatability of CLA showed a coefficient of $\omega^2 = 0.34$.

The measured milk yield tended to have an influence on the CLA (Table 2). Cows with low phenotypical 100-days