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Comparison of visual and computerized estrous detection and evaluation of influencing factors

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ABSTRACT

The aim of this study was to compare the automatic estrous detection system (AED) Heatime® with visual estrous detection (VED). The study was conducted on 139 Holstein Friesian cows in one dairy herd in Northern Germany. The cows were fitted with activity collars from d 21 postpartum until d 40 of gestation and a 30-min visual estrous observation was conducted three times a day. In addition, as a separate part of the VED, estrous detection by exclusive consideration of standing estrus (SE) was investigated. Ovulation detected by regular *trans*-rectal ultrasonography and serum progesterone analyses served as gold standard to calculate estrous detection rate (EDR) and reliability rate (RR) for each of the three estrous detection systems (AED, VED and SE). Change in body condition antepartum and postpartum, lameness, milk yield and milk fat- milk protein- ratio (FPR) on the expression and detection of estrus were investigated. Estrus was more precisely detected by the AED (EDR: 85.1%) than by VED (EDR: 52.2%) and SE (EDR: 22.3%) ($P < 0.05$). The RR when using the three methods did not differ ($P > 0.05$). Changes in body condition, lameness, milk yield or the FPR were not associated with the estrous detection rate by the AED. The estrous detection rate by VED in lame animals (EDR: 24.2%) was, however, less than in cows without any lameness (EDR: 52.7%; $P < 0.05$). In conclusion, the AED Heatime® system can be effectively used for estrous detection and can be used to more precisely detect estrus than with VED.

1. Introduction

Efficient estrous detection is an essential component of a successful reproduction management and a basis for an economic milk production (Nebel et al., 2000; Roelofs et al., 2010). Due to the intensification of agriculture, the resulting increase in size of dairy herds and increasing workload of farmers, the conditions for time-consuming visual estrous detection are becoming problematic. Moreover, there is a lesser expression of signs of estrous behavior and shorter duration of estrus as compared with dairy cows in historic production systems (Dobson et al., 2008). Inadequate estrous detection is reflected in poor conception rates (Diskin and Sreenan, 2000) and leads to reduced reproductive performance and thereby economic losses (Köhn, 2000; Becker et al., 2005). Additionally, endogenous and exogenous factors may reinforce unsatisfactory estrous detection. Thus, a negative effect by lameness (Walker et al., 2008; Morris et al., 2011), increased milk production (Lucy, 2001; Walsh et al., 2008) and increased peripartum loss of body condition (Buckley et al., 2003; Roche et al., 2009) was observed. Cows with a greater milk yield have a lesser expression of signs of estrous behavior and a shorter duration of estrus (Peter, 2007). Estrous detection rates should exceed 70% on dairy farms

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(Esslemont, 1992). Because even experienced observers are not able to recognize more than 40% to 60% of cows in estrus (Liu and Spahr, 1993; Heuwieser and Mansfeld, 1995; Firk et al., 2002; Rodrigues et al., 2010), farmers have a greater interest in newer technologies for estrous detection. Automatic methods, not only in the areas of feeding and milk production but also in estrous detection, have already been established on dairy cattle farms. The use of precision technologies for estrous detection allows for recognition of over 80% of cows in estrus (Cavalieri et al., 2008).

It was the aim of the present study to compare a fully automated estrous detection system with visual estrous detection for sensitivity and accuracy of estrous detection and to evaluate the applicability and functionality of systems on a modern dairy farm. For this purpose, the estrous detection (sensitivity) and the reliability rates (false positive rate) for estrous detection systems were determined and compared. In addition, it was investigated whether and to what extent, change in body condition antepartum and postpartum, lameness, milk yield and the milk fat- milk protein- ratio (FPR) are associated with the expression of estrous behavior and estrous detection.

2. Materials and methods

2.1. Animals and housing

The study was conducted on a dairy farm with 430 Holstein Friesian cows in Northern Germany. Of these, 139 cows (mean age 3.5 ± 1.7 years, body weight 607 ± 49 kg and BCS 3.25 [3.25/3.5]) were selected for the study. Cows were housed in stalls with a concrete slatted floor that were straw-bedded and milked three times a day. Non-lactating cows, cows that had recently initiated lactation and heifers in the latter stages of pregnancy were stabled in separate barn areas. The cows were fed a Total Mixed Ration (TMR) containing corn and grass silage as well as rye meal, distillers grain, rape seed meal, corn grain (ground), calcium carbonate, feed fats, salt (plain), mineral mix and magnesium oxide. Artificial insemination (frozen semen) was conducted by the farmer. The study was approved by the Lower Saxony State Office for Consumer Protection and Food Safety (LG − 05–01/2012).

2.2. Estrous detection

Cows were equipped with a transponder collar (Heatime® activity collar SCR HRLD, SCR Engineers ltd., Netanya, Israel) from d 21 postpartum until d 40 of gestation. The physical activity data of the animals were stored in 2-h cycles, captured three times daily by an infrared antenna and transmitted to a control station (Heatime®, SCR Engineers ltd., Netanya, Israel). The control station processed the data and calculated an individual activity graph for each cow. If a cow's physical activity exceeded a manually set threshold value, in this case over 5% of its average activity, the system signaled an estrus.

Visual estrous detection (VED) was performed three times a day for 30 min from d 21 postpartum until d 40 of gestation and was always conducted by the same person. For the observations, it was ensured that the cows were in a rest phase with an interval of at least 60 min prior to any handling (e.g., feeding, milking or moving). The behavior of the animals was assessed using a three-point scoring system according to Hall et al. (1959). SCORE 1 corresponded to a slight increase in physical activity, little vaginal mucus discharge or slightly increasing interest in herd members. SCORE 2 was given in cases of a great increase in activity, an increased vaginal mucus discharge and highly enhanced interest in herd members or standing to be mounted. Cows expressing standing estrus were given the SCORE 3. Animals which did not express the aforementioned behaviors were not detected. If two different scores were recorded in the same 30-min observation period, the greater score replaced the lesser score.

2.3. Estrous cycle monitoring

Trans-rectal ultrasonic examinations commenced on d 21 postpartum and were performed using a portable ultrasonic device (HS 101 V, HONDA Electronics CO., Tokyo, Japan). Thereafter, the cows were examined three times a week until an ovulation was detected (d 1 of the estrous cycle). Subsequently, on d 7 ± 1 of the estrous cycle there was an assessment conducted for the presence of a corpus luteum using ultrasonography.

Additionally, from d 21 postpartum to d 40 of gestation blood samples were taken to determine the progesterone concentration. After each estrous detection by the automatic estrous detection system (AED) or by VED, a blood sample was taken from the vena caudalis mediana (S- monovette 9 mL, Sarstedt Co., Nümbrecht, Germany) within 24 h. This procedure was also performed when a recently occurring ovulation was detected with ultrasonic examination but no estrus in temporal relation to ovulation was detected by the AED or the VED. Progesterone concentration in serum was analyzed quantitatively using an enzyme-linked immunosorbent assay (ELISA; Prakash et al., 1987) and a standard curve at the interval of 0.2 − 12.5 ng/mL. The intra- and inter-assay coefficient of variation were 9.6% and 12.5%, respectively.

2.4. Evaluation of estrous notifications

An ovulation was confirmed by the presence of an ultrasonically detected ovulation and additionally by a progesterone concentration of ≤1.0 ng/mL within 24 h before and after ovulation (OV-estrus; Hockey et al., 2010).This served as gold standard for the results of the AED and the VED. The sum of true positive and false negative estrous notifications data from the estrous detection system is equal to the number of all OV-estruses. The proportion of true positive estrous notifications to the total number of OV-estrous detections reflects the estrous detection rate (EDR) and, therefore, the sensitivity of a system.