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USE OF PEDOMETERS TO ANALYSE 24-HOUR ACTIVITY AND FERTILITY OF LIMOUSIN COWS

WYKORZYSTANIE PEDOMETRÓW DO ANALIZY AKTYWNOŚCI DOBOWEJ I PŁODNOŚCI KRÓW RASY LIMOUSINE

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Streszczenie. Badania przeprowadzono na krowach i jałówkach rasy limousine o liczebności po 10 sztuk w grupie, utrzymywanych na głębokiej ściółce z wybiegiem. Okres badań styczeń––luty z wykorzystaniem urządzeń do badania aktywności ruchowej produkcji izraelskiej (AfiAct) i japońskiej (GYUHO). Analizowano aktywność zwierząt przez 24 godziny, częstotliwość odpoczynku, średni czas spoczynku na jedno leżenie oraz oszacowano średni wskaźnik niepokoju. Stwierdzono najniższą aktywność dobową krów i jałówek w godzinach nocnych między 0.00 a 5.00, natomiast dzienna była prawie dwukrotnie wyższa od nocnej. Jałówki przy zwiększonej aktywności dobowej względem krów charakteryzowały się wyższym wskaźnikiem częstotliwości odpoczynku i krótszym czasem spoczynku na jedno leżenie. Wyższą stresowość odnotowano podczas rannego pomiaru w obu grupach. Efektywność obu systemów w wykrywaniu rui określono na średnim poziomie 85%, co daje rozkład 84% wśród jałówek i 85% wśród krów. Oba badane systemy dopuściły się do utracenia 1,5 rui w całym badanym stadzie.

Key words: 24-hour activity, beef cattle, Limousin, pedometers.
Słowa kluczowe: aktywność dobowa, bydło mięsne, limousine, pedometry.

INTRODUCTION

Loose housing of beef cattle does not allow for monitoring the activity of the herd and individual animals, thus making it more difficult to identify reproductive, health and behavioural problems. Of particular importance is the decrease in estrus detection efficiency in AI herds, in animals exhibiting excessive activity, and in animals with large differences in age and body weight. As a result, there is a search for other methods than the common observation (Nebel et al. 2000, Dochi et al. 2005, Mosaferi et al. 2012). One such method are electronic activity tags attached to the cows' legs (Peter and Basu 1986, Roelofs et al. 2005). Research has shown the activity meters to be highly effective not only in improving fertility but also in detecting leg disorders (Liu and Spahr 1993, Roelofs et al. 2005). The objective of the present study was to analyse changes in 24-hour activity of Limousin cows and heifers, and to determine the efficiency of different activity monitoring systems in improving the efficacy of estrus detection.

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MATERIAL AND METHODS

The study was conducted at the Kołbacz Experimental Station of the National Research Institute of Animal Production with Limousin cows and heifers (10 animals per group), which were kept on deep litter with access to an outdoor area during the winter period. The first group included 10 heifers and the second was comprised of cows after first calving. Housing and feeding conditions were the same for both groups (loose-housing barn) and the cows were kept in one sector. Israeli (AfiAct) and Japanese (Gyuho) activity tags were fitted to the front legs of each animal. Pedometer readings were taken for 40 (Gyuho) or 90 days (AfiAct) during the winter season at 8:00 am and 7:00 pm, and two measurement sessions were carried out: day-time session I (10:00 am to 6:00 pm) and night-time session II (8:00 pm to 6:00 am). Data were collected on 24-hour locomotor activity. The data were used to analyse the activity of animals over 24 hours, resting frequency (number of lying bouts per session), average amount of time spent resting per lying bout, and to estimate the mean indicator of distress. The efficiency of the pedometers as estrus detection aids in beef cattle was tested during at least two estruses. Our study did not account for physiological status of the cows because Anderson (1986) reported that the gestation period caused no significant differences in activity of the cows depending on whether they were during the drying-off or early gestation periods. Statistical analyses were performed with SAS statistical package based on one-way analysis of variance and GLM procedure.

RESULTS AND DISCUSSION

The lowest 24-hour activity of the cows and heifers was found to occur during the night hours (between 0:00 am and 5:00 am) with the least active cows and heifers between 3:00 am and 4:00 am (49 and 66 steps per hour, respectively; Fig. 1). Likewise, Wójcik and Rudziński (2014) observed lower activity during the night. Over the 24 hours, heifers exhibited higher mean activity than cows. Day-time activity of the cows and heifers was almost twice as high as night-time activity, which was also observed by Bogucki et al. (2012). Particularly large differences between the groups (all significant at $P \leq 0.01$) were noted between 5:00 am and 7:00 am (from 94 steps/hour in cows to 241 steps/hour in heifers) and between 1:00 pm and 5:00 pm (from 97 steps/hour in cows to 187 steps/hour in heifers). The fact that the activity readings were taken in the milking parlour and therefore the animals had to be driven twice (at 8:00 am and 7:00 pm) has increased the activity of these animals during these hours. The activity increased 2 hours before the planned measurement in both groups, but heifers reacted much more strongly. Both groups responded similarly to the end of activity readings but the reaction was markedly quicker in the cows. The second system (AfiAct) showed that with increased 24-hour activity, heifers were also characterized by higher resting frequency and shorter resting time per lying bout ($P \leq 0.01$). During the night--time session (between 8:00 pm and 8:00 am) resting frequency was 9.06 in heifers and 7.72 in cows, and during the day-time session (between 10:00 am and 6:00 pm) it was 7.20 and 5.26, respectively. The average resting time ranged from 49.8 to 56.6 min/lying bout in heifers and from 59.1 to 61.0 min/lying bout in cows, with higher values noted during the

night. The study also showed that although heifers were more active than cows, total resting time was longer in the first group by an average of 23 min during the night and by 31 min during the day (P ≤ 0.01). These results are in agreement with the observations of Bogucki et al. (2012), who reported that in winter animals took over 2.5 times more time to lie in the stall at night than during the day.

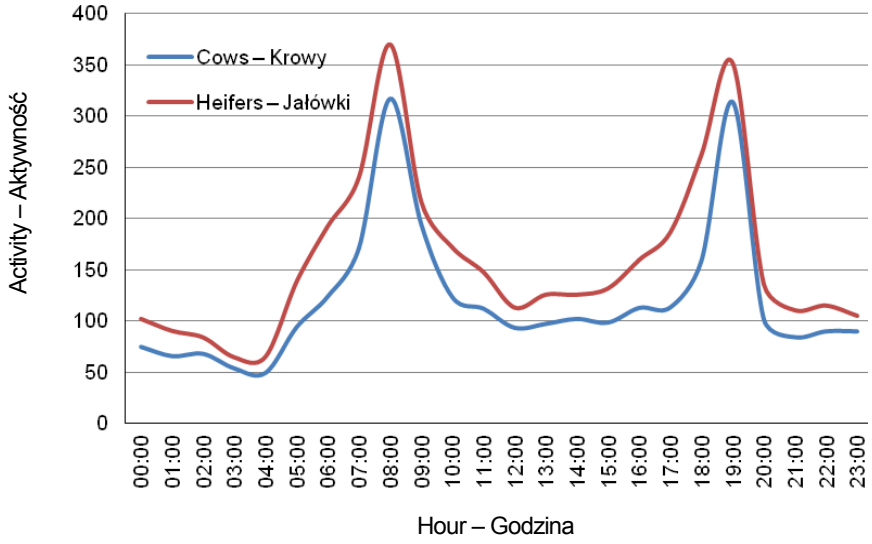

Fig. 1. Hourly activity of the cows and heifers based on the Japanese Gyuho system
Rys. 1. Aktywność godzinowa krów i jałówek wg systemu japońskiego GYUHO

When analysing night-time activity of the cows and heifers (8:00 pm to 6:00 am) in five--day periods based on the Gyuho system, considerable differences were found between the groups (Fig. 2). The lowest activity was found in both groups during the morning hours (4:00 am): 31 steps/hour in cows (group average of 49) and 41 steps/hour in heifers (group average of 65) (P ≤ 0.01). During the night hours, the mean activity ranged from 49 to 124 steps/hour in cows (P ≤ 0.01) and from 65 to 194 steps/hour in heifers (P ≤ 0.01). As noted by Bogucki et al. (2012) and Sablik et al. (2010), during that time feed and water intake clearly decrease while resting time increases. The AfiAct system showed that in the studied period heifers rested more frequently than cows (9 vs. 7 times per session), but the average resting time per bout in heifers was shorter than in cows (56 vs. 61 min), which was confirmed statistically (P ≤ 0.01). Thus the indicator of distress was higher in heifers (2.2) than in cows (1.7) (P ≤ 0.01).

In terms of day-time activity, the studied groups were most active in the morning (10:00 am) and during midday hours (6:00 pm), and least active between 12:00 pm and 2:00 pm (Fig. 3), which was statistically confirmed (P ≤ 0.01). Higher morning activity was also reported by Sablik et al. (2010) in pastured cattle. The situation was similar at night when heifers were more active than cows by 20 to over 120 steps/hour (P ≤ 0.01). Therefore, the AfiAct system showed that mean resting time was shorter in heifers (50 min) than in cows (59 min), as reflected by the higher indicator of distress in heifers (3.20) compared to cows (2.87). The differences between the groups were statistically significant (P ≤ 0.01).

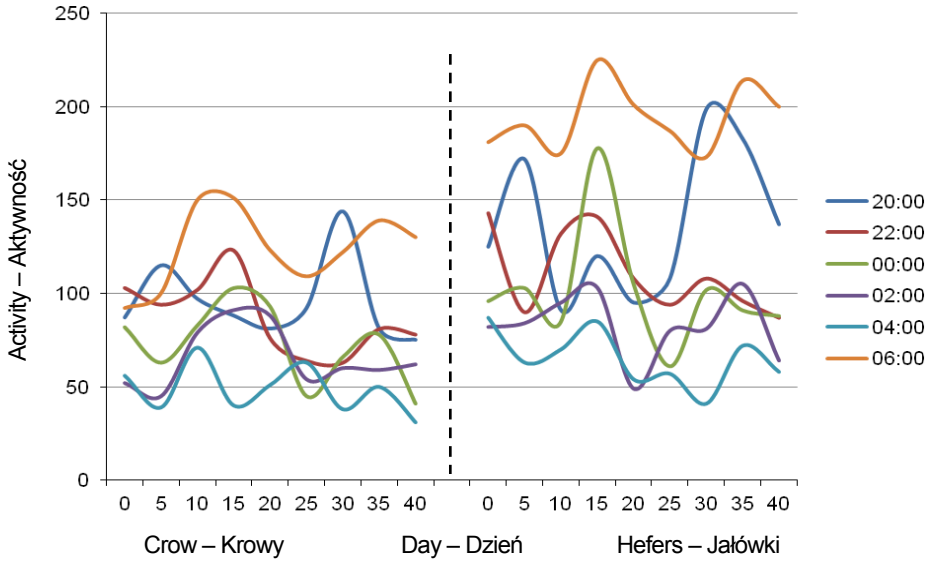

Fig. 2. Night-time activity of cows and heifers during the studied 40-day period according to the Japanese Gyuho system
Rys. 2. Aktywność nocna krów i jałówek w okresie badanych 40 dni wg systemu japońskiego GYUHO

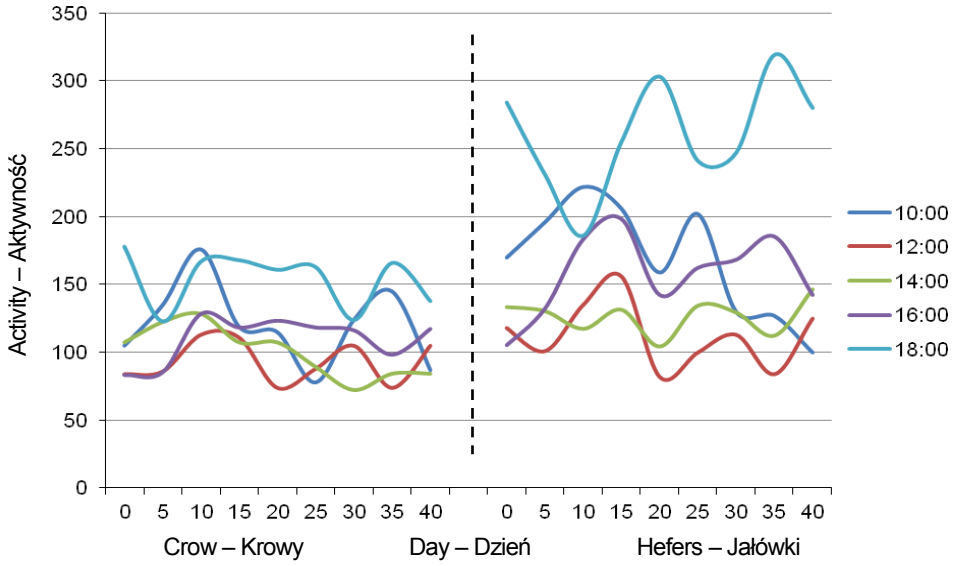

Fig. 3. Day-time activity of cows and heifers during the studied 40-day period according to the Japanese Gyuho system
Rys. 3. Aktywność dzienna krów i jałówek w okresie badanych 40 dni wg systemu japońskiego GYUHO

The analysis of cow and heifer activity during the most stressful period of activity measurement at 8:00 am and 7:00 pm as well as the hours before and after the reading are presented in Figure 4. The study showed that heifers had higher stress levels than cows, which translated into a greater number of steps per hour. These differences averaged from 23 steps ($P \leq 0.05$) to 70 steps ($P \leq 0.01$) during the morning hours (7:00 to 9:00 am), and from 35 to 104 steps/hour ($P \leq 0.01$) during the afternoon hours (6:00 to 8:00 pm). Higher stress levels were noted in both groups during the morning compared to the evening

measurement; however, greater differences between peak stress and the measurement made an hour after the activity were observed in the afternoon measurement ($P \leq 0.01$). These observations are reflected in the distress indicator calculated based on the AfiAct system. Heifers not only achieved higher values (from 2.24 to 3.28) than cows (from 1.75 to 2.89); higher values were also observed in the afternoon than in the morning session. One hour after the measurement, the activity decreased by 122 to 155 steps/hour in the morning and by as much as 215 steps/hour in the afternoon. The fact that the measurements were always made at the same hour caused a gradual decline in the excessive activity of the cows on consecutive days, which was not observed in heifers. Thus, the heifer group was more susceptible to stress due to the readings. A study with dairy cattle (Wójcik and Rudziński 2014) also demonstrated that after the night cows were much more active (distressed) when milked at 6:00 am ($P \leq 0.01$) than before the same activity in the midday and afternoon hours.

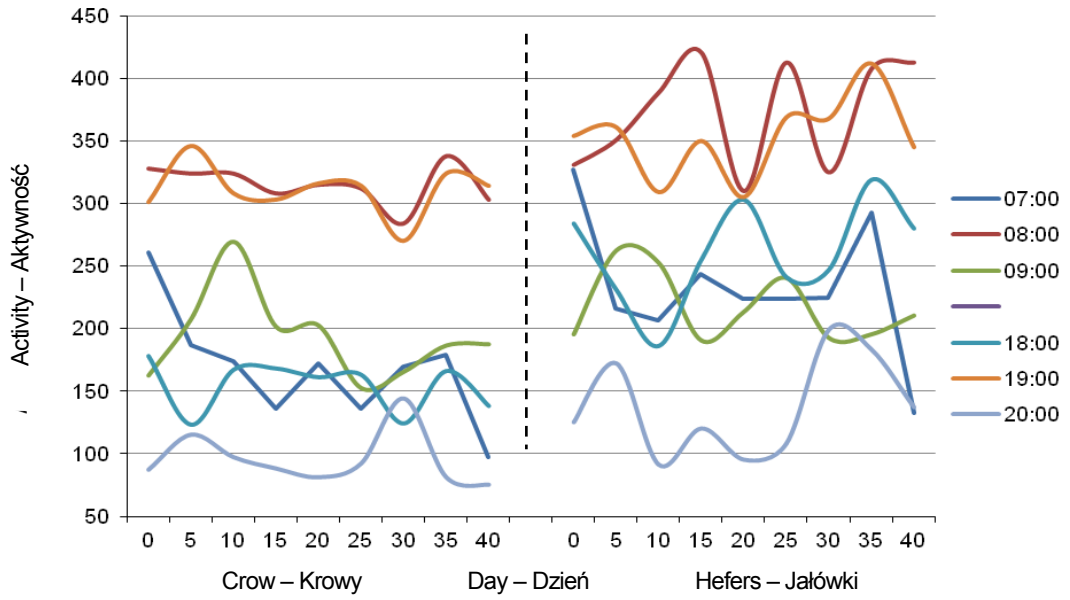

Fig. 4. Activity of cows and heifers subjected to higher stress situation at 8:00 am and 7:00 pm during the studied 40-day period according to the Japanese Gyuho system
Rys. 4. Aktywność krów i jałówek w sytuacji podwyższonego stresu w godzinach 8.00 i 19.00 w okresie badanych 40 dni wg systemu japońskiego GYUHO

Analysis of the 24-hour activity of cows and heifers was also used for estrus detection. In the analysed period, 61 estruses were found in 20 cows based on veterinary examination, which gives an average of 3 estruses per cow. Considering that both systems showed excessive activity of the animals, being indicative of estrus, the efficiency of the systems was found to average 85%, namely 84% in heifers and 85% in cows. In the studies of Roelofs et al. (2005), Holman et al. (2011) and Liu and Spahr (1993) this indicator ranged from 51 to 87%, whereas in the study of Peter and Bosu (1986) 75% ovulations were confirmed by pedometers, with only 35% of the cows showing the external signs. Under both analysed systems, only 1.5 estruses were missed in the beef herd. This was tantamount to the efficiency of 97% in both systems, whereas in an earlier study by Wójcik and Rudziński (2014) with dairy cattle, this indicator was 95%.

CONCLUSIONS

In summarizing the results obtained for Limousin heifers and cows, the study found the pedometers used in the beef herd to be highly effective. Compared to cows, heifers were characterized by higher 24-hour activity, greater resting frequency and shorter resting time per lying bout. At the same time they exhibited higher stress levels than cows, which translated into a greater number of steps taken per hour. Higher stress levels were observed during the morning measurement in both groups, whereas estrus detection efficiency averaged 85% (84% for heifers and 85% for cows). Both monitoring systems missed only 1.5 estruses across the whole beef herd.

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Abstract. Limousin cows and heifers (10 animals per group) were kept on deep litter with access to an outdoor area. The study was conducted in January and February using Israeli (AfiAct) and Japanese (Gyuho) activity monitoring systems. Twenty-four-hour activity patterns, resting frequency, average amount of time spent resting per lying bout were analysed, and the mean indicator of distress was estimated. The cows and heifers showed lowest 24-hour activity during the night hours (between 0:00 am and 5:00 am), and day-time activity was almost twice as high as night-time activity. With increased 24-hour activity in relation to cows, heifers were characterized by higher resting frequency and shorter amount of time spent resting per lying bout. Greater stressfulness was observed during the morning measurement in both groups. Estrus detection efficiency averaged 85% for both systems (84% for heifers and 85% for cows). Both monitoring systems missed 1.5 estruses across the whole herd.