

CIRCADIAN ACTIVITY OF DAIRY EWES KEPT INDOORS*

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Abstract

The aim of this study was to characterize the activity of Polish Milk Sheep 05 ewes housed in the indoor system. One group of 28 animals was observed. The observations lasted 227 hours and were conducted during day and night. The activity of each ewe was recorded every 10 minutes. The observed sheep rested for most of the day. Their activity increased at dawn, during milking (and feeding) and after green forage was provided in the afternoon. The time of feeding was mostly dependent on human activities. Rumination always occurred after the feed was offered. Sheep mainly slept lying down after milking and at night. REM (Rapid Eye Movement) sleep was observed. There were statistically significant ($P \leq 0.05$) differences in individual forms of behaviour (moving, standing, lying, feeding and ruminating) between different times of the day. In conclusion, the activity pattern of the indoor-housed ewes resembled that of pastured ruminants, but it was also strongly influenced by farm staff (milking, feeding, etc.).

Key words: daily activity, behaviour, ruminant, feeding pattern

The behaviour of sheep (*Ovis aries*) is strongly related to the fact that they are ruminants and are gregarious by nature (Hulet et al., 1975). The circadian activity of sheep, especially grazed ones, is determined by the environmental factors. Piccione et al. (2010, 2011) claimed that locomotor activity of sheep during the day is influenced by food availability and light/dark cycle. The activity can also change periodically, for example depending on seasons. Arnold (1962) found that grazing usually began at dawn and ended at dusk. In the spring and summer the grazing reached two peaks, while in the autumn and winter, it reached only one. The proportion of grazing between 6:00 a.m. and 6:00 p.m. changed depending on the season and it was the highest in spring and early summer. Dudzinski and Arnold (1979) stated that the time of starting and ending major morning and afternoon grazing periods and the time spent grazing on particular days depended on the time of dawn or dusk,

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air temperature, humidity and the time spent grazing the previous night. Piccione *et al.* (2008 b) observed that in goats there was one peak (in the middle of the day) of the activity rhythm. The same authors also noticed that the daily rhythm of activity displayed seasonal variations.

Previous research of daily activities in sheep was mostly concerned with pasture management and grazing of sheep along with goats. Animut and Goetsch (2008) noticed significant discrepancies in measurements of distance travelled depending on the environmental conditions and measurement methods. Stevenson *et al.* (2004) observed the behaviour of feral Soay sheep on the island of Hirta in St. Kilda archipelago (north-western shore of Scotland) and found that the time spent for sexual activity, feeding and moving was different depending on the season. Second half of November was characterized by a distinct increase in sexual activity and moving with a simultaneous decrease in the time spent feeding compared to the summer and winter periods.

Behaviour of domestic animals is affected not only by daily and annual changes in the environment (light, air temperature, humidity, etc.), but also by smaller living space and greater stocking density in indoor systems, and by management practices. The behavioural observations of sheep kept indoors showed that the duration of specific activities varied according to the type of sheepfold (Nowicki and Zwolińska-Bartczak, 1983). The activity of sheep kept indoors (milking, feeding, etc.) was mainly controlled by humans. Piccione *et al.* (2008 a), who investigated general activity in animals kept under artificial conditions (12:12 light:dark cycle) without any social contact, found that sheep and goats were mostly diurnal animals.

Hutchins *et al.* (2003) stated that sheep and goats were domesticated earlier than other farm animals. Sheep breeding gives many benefits to humans by providing meat, milk and wool, among others. Among the many breeds and varieties found all over the world are Polish Milk Sheep 05.

Polish Milk Sheep 05 were raised in the experimental farm in Złotniki, belonging to the Poznań University of Life Sciences. The genotype of this variety is based on the East Friesian (13/16) and Polish Merino sheep (3/16) (Annexe..., 1999). East Friesian sheep are a unique breed in that they rather do not tend to join other individuals and seek contact with humans (Schwintzer, 1983). However, this does not mean that they cannot be kept in a group of 40 other animals with proper space allowance and access to feed and water (Gräser-Herrmann and Sambras, 2001). The purpose of this study was to characterize the activity of Polish Milk Sheep 05 ewes housed in the indoor system.

Material and methods

The observations were conducted on the farm in Złotniki near Poznań, Poland. The observed group contained 28 non-pregnant ewes of the Polish Milk Sheep 05 aged between 2 and 7 years (mean \pm SD: 3.71 \pm 1.46). Sheep were milked at 6:00 a.m. once a day in a side-by-side milking parlour. They received green forage and

hay in the afternoon (2:00 p.m.) and supplementary forage during milking. All feeds were provided *ad libitum*. The animals were housed together in a sheepfold. The total space available for the observed group was 175 m² (6.25 m² per sheep), which represents a low density compared to usual farming conditions (0.8 m² per sheep) (Regulation..., 2010). All sheep were individually spray marked with numbers.

The observations were conducted in summer between 27 July and 9 September. Instantaneous scan sampling was used (Altmann, 1974) and the activity of each animal was recorded every 10 minutes. Animals were observed for a total of 227 hours. All observations were made by the same person. The behavioural categories observed were ruminating, drinking, feeding, self-grooming, sleeping, social behaviour, moving, and vocalization, but not all of these categories were taken into account.

The day was divided into three eight-hour blocks: morning (5:30 a.m. – 1:20 p.m.), afternoon (1:30 p.m. – 9:20 p.m.) and night (9:30 p.m. – 5:20 a.m.). The observations in each block were made for 10 days. Because some hours were missed in every block, 227 h of observations were made. Preliminary observations revealed that sudden turning on of the light at night caused ewes to awake and consume feed. The increased activity persisted for an hour, after which sheep went to sleep again. As a result, five days before night observations the animals were accustomed to the light. Light was turned on right after sunset, left for the night and turned off during the morning milking about 6:00 a.m., when it was bright outside. During the night observations, with lights turned on early enough, the ewes did not awaken as described previously. Four light bulbs were used to illuminate the pen (3 × 60W and 1 × 75W).

In order to show the general proportions of each activity during the day, we calculated the mean for each one, where 100% was the number of all observations of any activity. The results were analysed in two ways: general activity analysis and finer behavioural analysis.

For the calculations of statistical differences in all cases, the G test was used at the significance level of $P \leq 0.05$. We checked if standing, lying, moving, ruminating, feeding and sleeping are dependent on time of day (morning, afternoon, evening) and analysed behaviours in standing and lying positions. To check if ruminating, feeding and sleeping are correlated, Spearman's correlation test was used.

Results

The proportion of moving, standing and lying during the day differed significantly (moving $G = 84.92$, standing $G = 308.75$, lying $G = 560.04$; $P \leq 0.05$). In general, an increased proportion of standing posture was observed during the feeding of green forage (afternoon) and during milking (morning) (Fig. 1). During the remaining hours, the ewes were mostly lying. A seven-fold increase in records presenting moving (morning), in relation to the average, was the result of animals' movement into and outside the milking parlour (Fig. 1). Ewes were becoming active also in the

evening, when the temperature outside was lower. In the total number of records, 50.5% accounted for standing posture, 44.8% for lying posture and 4.7% for moving.

The analysis of lying and standing postures is presented in Table 1. Between 5:30 and 7:20 a.m. the lying posture was not analysed, because it was the time before and after milking with a significant decrease in the proportion of lying posture in general (Fig. 1).

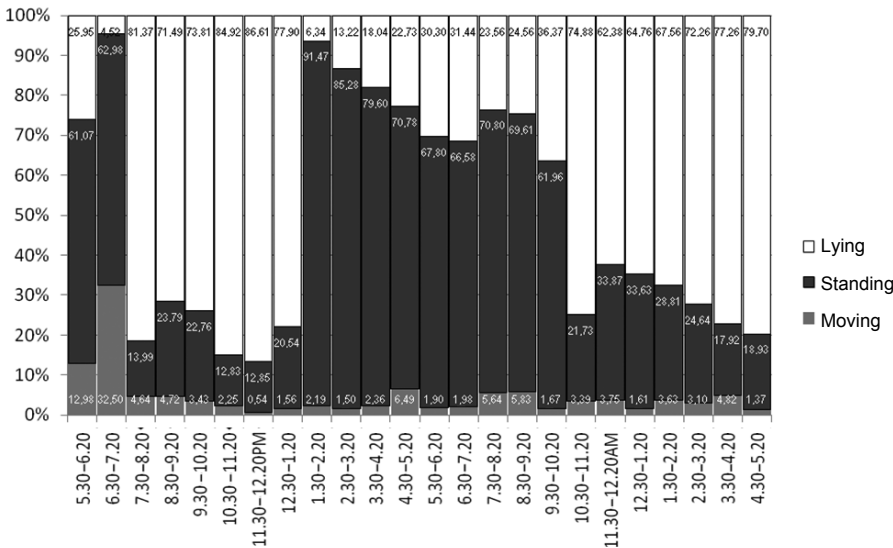


Figure 1. Percentage of basic activities during consecutive hours. Group means in total observations

Table 1. Percentage of specific behaviours in standing and lying posture

	Ruminating	Feeding and drinking	Idling	Sleep	Total
Standing	30.51	38.11	29.64	1.74	100.00
Lying	35.48	0.00	13.55	50.97	100.00

Figure 2 presents the schedule of ruminating and feeding during the day. There was a significant negative Spearman correlation between feeding and sleeping (-0.82 ; $P \leq 0.05$). The correlation between feeding and ruminating was also negative (-0.50 ; $P \leq 0.05$). On the other hand the correlation between ruminating and sleeping was positive (0.47 ; $P \leq 0.05$). The increase of feeding was related to the decrease of ruminating and vice versa. The difference in ruminating frequency, dependent on the time of day, was statistically significant (feeding $G = 154.05$; ruminating $G = 343.72$; $P \leq 0.05$). After receiving the supplementary forage during milking (5.20–7.20 a.m.) sheep were ruminating. About 2:00 p.m., after green forage was

offered, sudden feeding activity was noticed, which gradually decreased in favour of ruminating. Sheep were ruminating mostly lying (61.78%). There was no record of eating in lying position.

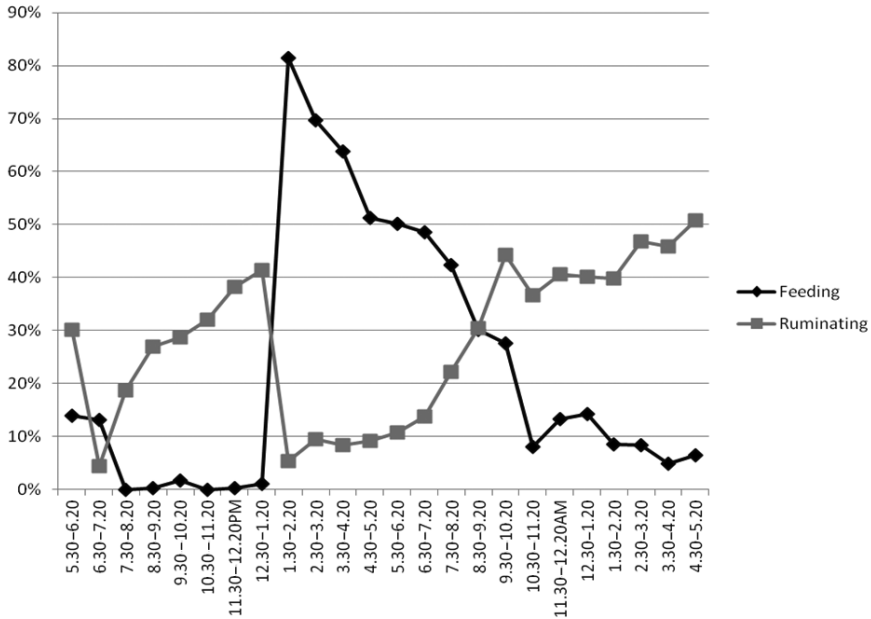


Figure 2. Feeding and ruminating during consecutive hours. Group means in total observations

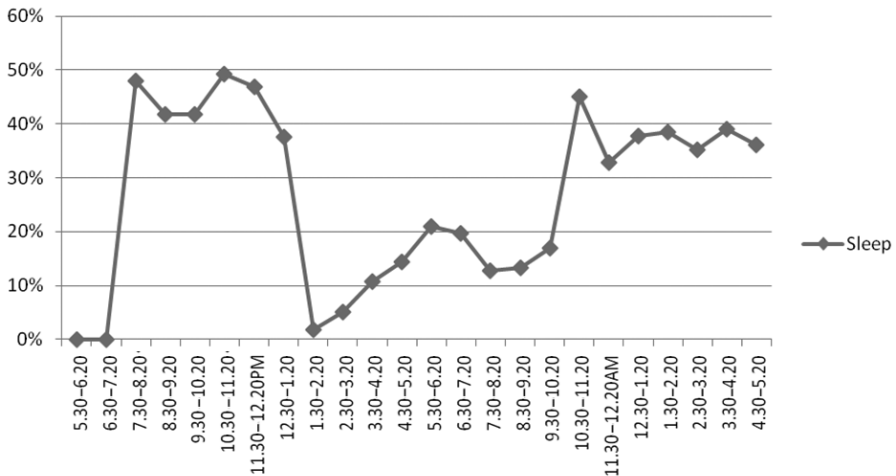


Figure 3. The proportion of sleep in consecutive hours. Group means in total observations

The locomotor activity of sheep was increasing during the time of eating alfalfa and at dusk. On the other hand, until noon and at night, more than one-thirds of

records showed sleep (Fig. 3). In total, sleep represented 29.34% of records. Sheep were sleeping after milking (7:20 a.m.) until the green forage application (2:00 p.m.), when the sudden movement began. Next, the sleep percentage was growing until dusk, with a small decrease about 7:30 p.m. Ewes slept mostly lying (97.36% of the observations). The difference in the proportion of sleep, dependent on the time of day, was statistically significant ($G = 471.39$; $P \leq 0.05$).

Discussion

The largest proportion of moving was noticed during the time of milking (5:30–7:20 a.m.). Lying posture was observed mainly after milking (7:30 a.m.) until green forage application (2:00 p.m.) and from about 10:00 p.m. until morning milking. Standing posture was observed mainly during eating of green fodder. Nearly 80% of records showed rest, which comprised the following behaviours: lying idle, lying and ruminating, standing idle, ruminating in standing posture, and sleeping in standing and lying posture. According to Chudoba *et al.* (2000), sheep breeds differ from each other by the amount of time spent resting; for example, Suffolk sheep kept on pasture for 24 hours spent 56.3% of this time resting. The difference in resting time between our own observations and those made by Chudoba *et al.* (2000) may relate to the sheep farming system, because sheep on the pasture are forced to look for their food actively, while sheep kept indoors have their food in one place and do not have to look for it. What is more, Rutter (2002) claimed that sheep typically spend 8 hours grazing, whereas goats spend 11 hours 'browsing'. According to the author goats are more inclined to browse for food (leaves, bushes, etc.) even when grass is bountiful. Cows kept in a loose barn spent 36.32% of the day standing, 49.44% lying and 14.24% feeding (Neja and Bogucki, 2005). The observed Polish Milk Sheep 05 spent more time feeding (23.29% of the day). Sztych and Wilczak (2005) reported that goats spent 57–69.5% of the day lying, which is much more than observed for sheep 05 (44.8%). Moreover, these authors observed increased activity at feeding time, which is in agreement with our observations.

The group of observed ewes had two feeding times: in the morning and afternoon. This was due to the fact that supplementary forage was provided in the morning and green forage in the afternoon. For comparison, sheep kept on pasture all the time are also grazing periodically but with four cycles per day (Hughes and Reid, 1951; Nowicki and Zwolińska-Bartczak, 1983): at dusk, in the early morning, before noon, and from noon till dusk (the longest cycle). Neja and Bogucki (2005), who observed tethered cows, confirmed Jezierski's argument (1987) that with rationed feeding, the daily rhythm of feed intake depended mostly on the time of forage feeding. Where cows were kept freely and had access to the fodder all the time, most of them ingested feed within 1.5 h of milking. According to Fraser (1980), grazing activity of sheep occurs only during the day and begins at sunrise. Overall time of grazing on a pasture is about 10 hours, with 4–7 grazing periods. Periods of the most intensive grazing in the summer are in early morning and from afternoon until dusk (Fraser, 1980). These

observations are consistent with the times when sheep 05 received green fodder and hay, but feeding time was controlled by humans in our study.

Sheep ruminate several times per day, mainly during the night hours (Nowicki and Zwolińska-Bartczak, 1983), and during grazing the proportion of rumination is much smaller. We observed a similar rumination and feeding pattern in ewes 05, namely increased frequency of rumination after the supplementary forage was provided, and a similarly high proportion from about 9:00 p.m. to 5:00 a.m. (Fig. 2). Also Sztych and Wilczak (2005) reported that goats ruminated mainly at night. Fraser (1980) stated that sheep ruminate with irregular gaps at night and during the day. Research conducted on a herd of ewes by Borys et al. (1990) showed that sheep kept in sheepfold spent 34.7% of their time ruminating, two-thirds of which was in lying posture and one-third in standing posture. Similar results were obtained during our observations, with a lower proportion of rumination (28.13% of records) and similar proportions of lying (61.78%) and standing (38.22%) postures.

According to Fraser (1980) sheep are active for 16 hours and sleep for about 4.5 h per day. In the observed group, one-fourth of the records indicate sleep, mostly lying. Piccione et al. (2007, 2008a) reported that sheep and goat activity is mostly diurnal. Our results are consistent with their findings: in the observed group, a strong decline in activity was observed after milking and at night. Hobson (1994) listed 3 repeated sleep phases: waking, non-REM (non-rapid eye movement) and paradoxical sleep phase or the REM phase (rapid eye movement). In our study, sleeping sheep happened to bleat and move their limbs, which indicated the latter sleep phase.

To conclude, the activity of the observed ewes resembled the pattern observed in pastured ruminants, but was also strongly influenced by farm staff (milking, feeding).

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Aktywność dobową macierek mlecznych utrzymywanych w chowie alkierzowym

STRESZCZENIE

Celem niniejszej pracy było scharakteryzowanie aktywności macierek owcy mlecznej 05 utrzymywanych w chowie alkierzowym. Przeprowadzono 227 h obserwacji (obejmujących dzień i noc) dwudziestu ośmiu osobników tworzących jedną grupę. Aktywność każdej owcy była notowana co 10 min. Obserwowane maciorki odpoczywały przez większą część doby. Ich aktywność wzrastała o świcie, podczas doju (i podawania paszy) oraz po popołudniowym podaniu zielonki. Pory pobierania pokarmu zależały głównie od aktywności człowieka. Przeżuwanie występowało zawsze po podaniu paszy. Owce spały głównie w pozycji leżącej, po doju i nocą. Zaobserwowano fazę snu REM (Rapid Eye Movement). Części doby różniły się istotnie ($P \leq 0.05$) pod względem występowania poszczególnych form zachowań (chodzenia, stania, leżenia, pobierania pokarmu i przeżuwania). Wzorec aktywności obserwowanych macierek przypominał wzorec aktywności wypasanych przeżuwaczy, jednak silnie wpływała nań również obsługa gospodarstwa (karmienie, dój, itp.).