MONITORING OF CATTLE PHYSICAL ACTIVITY DEPENDING ON WEATHER

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Weather and the climate have always exercised influence on almost every activity of the human society. Apart from the transport, construction and water supplies, it is especially the agriculture – crop and animal production. The impact of individual meteorological variables is essential for the farmed animals which are for most of the year out to pasture. It is appropriate to learn about these influences not only from the viewpoint of the cattle production economy but also due to the welfare of rearing bovine animals. One of the animal well-being indicators is the physical activity of animals.
This paper is aimed to monitor and evaluate the physical activity of the cattle depending on the changing weather. The work itself was carried out in the ZEMAV agricultural cooperative in Dolní Dvořiště from 1 March 2014 to 31 March 2015. The physical activity was monitored using the pedometers attached to the neck of cows. A total of 12 animals were selected for the experiment. The hydrometeorological data were obtained from the OREGON station and for the purposes of the check also from the nearest Czech Hydrometeorological Institute´s meteorological station located in Vyšší Brod.
The zootechnical and veterinary data on both the selected 12 cows and the whole herd were also obtained from the ZEMAV agricultural cooperative. These data serve to compare the performance and the state of health of animals depending on the weather conditions.

Keywords: cattle breeding, meat bovine breeds, physical activity, air temperature, air humidity, atmospheric pressure, velocity and direction of air flow, sunshine, atmospheric precipitations, welfare

INTRODUCTION

The people continue to increase their requirements and demands for the quality of the animal products. Thanks to the success in the breeding sphere, we achieve higher performance of farmed animals. The demands of animals for the conditions of their breeding, however, increase, too. The farmed animals are now being mostly kept in the restrained area and often according to the subjective ideas of the human being. In many cases they are wrong and different from what the animals really need. Not only the cattle breeding needs to monitor the influence of individual factors of the environment, including their interactions, to achieve better conditions for rearing the given breed and to make most of its genetic potential. In case of the housed animals, it is especially the technology of housing, feed quality and quantity, animal treatment and the basic zoohygiene. The proper microclimate of cowsheds should not be forgotten, either.

In case of the meet breeds of bovine animals kept for the major part of the year on free pastures, we must also add the influence of individual meteorological factors. We, of course, cannot change weather. But we can choose the appropriate bovine breed according to the demands for the habitats. It means to consider the altitude, local climate and the exposition of the given place. The relationship between an organism and the surrounding environment is created by a certain system (Černý et al., 1984). The system works in such a way that it maintains the balance among individual components and when the balance is disrupted by any action, the new one will form. The lower the number of such disruptions is, the higher efficiency in the nutrient conversion is achieved. If the lower and/or upper critical value for the environment temperature is exceeded, the performance of an animal is reduced (Novák et al., 2000). There is a whole complex of interactions between the environmental factors and the organism affecting the health condition (Brouček et al., 1995). Every breeder should know natural demands of their animals for the environment and should meet them as far as possible. One of the main preconditions for successful breeding is to meet the animals´ demands and needs and to ensure the environment allowing the animals to maximise their performance (Kunc and Knížková, 1996). Welfare of the reared animals needs to be maintained at the same time.

Ambient temperature has a major impact on the reared animals. We cannot understand it only as the air temperature, but in case of the housed breeds also as a combination of the temperatures of air, floor, bedding, walls or other technological equipment of the cowshed (Sova et al., 1990). Most bovine breeds are able to adapt to the temperatures at the place of their common and natural stay. It is, however, more difficult for the cattle to withstand sudden changes in temperature or extreme temperature values (Bukvaj, 1986). The influence of air temperature on the cattle has also a significant effect on the current air humidity and the velocity of air flow (Novák et al., 1994).

Air humidity is another very important indicator. It has a major influence on heat losses of animals. The main sources of air humidity in cowsheds are the reared animals themselves as well as the wet surfaces. The intensity of vapours depends on the degree of saturation with vapours and the air flow velocity. A very dry air with relative humidity less than 35 % makes the mucous membranes dry and may support the intrusion of infection into a body through the mucous membranes of the upper respiratory tract. What is more, the dust level is increased, too. The cold and damp air, on the other hand, takes more heat from the body surface, which is a problem especially in the winter periods. This leads to higher heat losses of an organism and the lower efficiency of the feed use. Dolejš et al. (1994) states the optimal value of the relative humidity for all types of stalling and age categories of the cattle of 50 to 70 %.

Air flow affects the reared animals especially in combination with the air temperature and air humidity. Gebremedhin (1987) notes that it is the air flow velocity which is the basic factor affecting the heat loss through the fur. Especially draught should be prevented in cowsheds; the animals grazing on pastures should have some shelters to protect themselves against wind and/or atmospheric precipitations.

Cooling ability of the environment is the variable which defines how much heat is transferred from the livestock body surface to the vicinity of animals for a certain period of time. It depends on the current climatic situation. The optimal values for

the adult bovine animals according to Šoch (2005) range from 290 to 420 $W.m^{-2}$.

Chemical composition of the atmospheric pressure is almost invariable all over the planet Earth. Nitrogen – 78.09 % and oxygen – 20.95 % have the highest share, followed by argon – 0.94 % and carbon dioxide – 0.028 to 0.035 %. Noble gases are present at trace levels. Out of the inhaled oxygen, the cattle use around 25 % and they raise the amount of carbon dioxide in the exhaled air about 130 times (Dobšinský et al., 1976). Chemical composition of the cowshed air is, however, always different from that of the atmospheric air. It is characterised by higher humidity and higher concentration of the cowshed gases that are products of breathing or digestion or arise during the biochemical processes in the bedding.

Solar radiation is a source of heat and light, having effect on metabolic processes in the bodies of animals; it supports growth and stimulates the activity of the central nervous system. Its wavelength and intensity affects the performance and welfare of animals (Košař and Chaloupková, 2000). The bovine animals mostly prefer the illuminated places over the dark ones (Doležal and Bílek, 2001).

Atmospheric pressure variation does not probably have an effect on healthy bovine animals (Matoušek, 1988).

Introduction of new technology in cowsheds mostly results in the higher noise level. This has an influence on the central nervous system and may affect the performance. The sound pressure level causing the stress differs with individual kinds and breeds of animals. There is usually no problem with noise under grazing conditions.

Little is still known about the effects of electromagnetic and magnetic fields on living organisms. The strong magnetic fields of 1 to 10 Tesla are known to disturb the blood function and they affect the nervous system activity (Šoch, 2005). The animals are also influenced by the geopathogenic zones – some of them search for them, some of them (including the bovine animals) are harmed by them.

MATERIALS AND METHODS

Monitored Herd

The physical activity was monitored on the meat bovine breeds. The breeds namely included Black Angus, Red Angus, Charolais, Beef Simental and Limousine cattle, including their cross-breeds. A total of 12 animals (K1 – K12) was included in the experiment.

Physical Activity Monitoring

The physical activity of the cattle was monitored using the pedometers hung on the cow collars on the neck of animals. Monitoring was carried out from January 2014 to March 2015; due to the system error, however, the only available data are for the period from March 2014 to March 2015. Data from the pedometers were transmitted using an aerial on the periphery of the corral to the laptop in the shelter. The sequences of 12 consecutive last data from the pedometer were always downloaded – one value every hour. The data from the pedometer were always rewritten after every hour. It was, however, necessary that the animal was standing near the aerial in the relatively short period of time when the signal was transmitted from the pedometer. If this did not happen, the data were not transmitted into the laptop. To minimize these data losses, the things attracting the cattle were put around the aerial, namely the fresh water tank, lick log or a straw bale. The data transmission system was designed in such a way that the battery in the pedometer lasts as long as possible, i.e. not that the pedometer could transmit data more often (continually). The device is sealed into the plastic so that moisture or mechanical damage could not have an adverse effect on it, otherwise there will be a big problem with replacing batteries in pedometers. The cattle would have to be chased away into the fixation cage and the pedometers would have to be removed to replace the batteries. Then, the pedometer would have to be put on the animals again. This system for measuring the cattle physical activity was borrowed from the Agrosoft Tábor company.

Meteorological Variables

In parallel with the physical activity monitoring, the meteorological variables were also measured using the Oregon meteorological station. It was installed in the laptop and the sensors were attached on the wooden column not far from the cowshed at the places the animals were not allowed to go. The goal was to approach the measuring conditions in the conventional meteorological booth. The data were saved in the laptop on a continuous basis. The software for the meteorological station and the sensors are owned by the Landscape Management Department of the Faculty of Agriculture, University of South Bohemia in České Budějovice. To check the measurement of meteorological indicators, the data were purchased from the České Budějovice office of the Czech Hydrometeorological Institute for the Vyšší Brod location (variables: air temperature at 7 a.m., 2 p.m. and 9 p.m., then air humidity at 7 a.m., 2 p.m. and 9 p.m., air flow velocity at 7 a.m., 2 p.m. and 9 p.m., direction of air flow at 7 a.m., 2 p.m. and 9 p.m., total precipitation for individual days and number of hours of sunshine a day. And for the Jenín location, the value of air atmospheric pressure converted to the local altitude was provided.

All obtained data were statistically processed in the Microsoft Excel program.

RESULTS AND DISCUSSION

In every three months of monitoring, we chose such a period in which the activity from the highest number of cows was known or the period with the known data on the physical activity was the longest. Whereas the only available system was that for measuring the physical activity in the cowshed premises where the animal was still within reach of an aerial and the real measurement was done on the pasture, the physical activity data are not fully continuous.

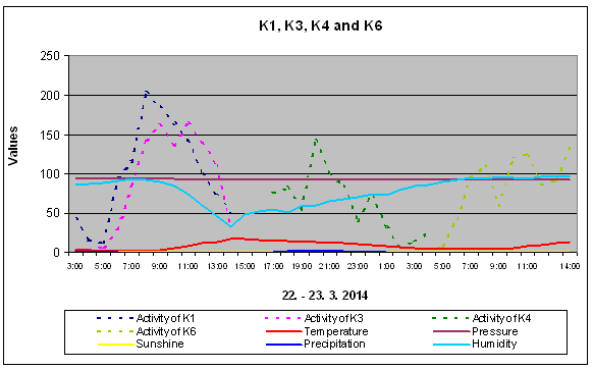

Figure No. 1: Physical activity of cows between 22 and 23 March 2014

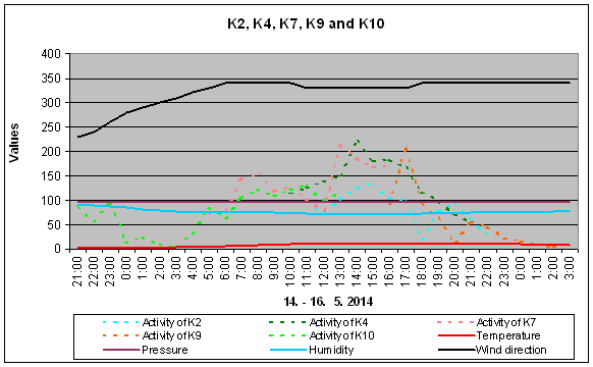

Figure No. 2: Physical activity of cows between 14 and 16 May 2014

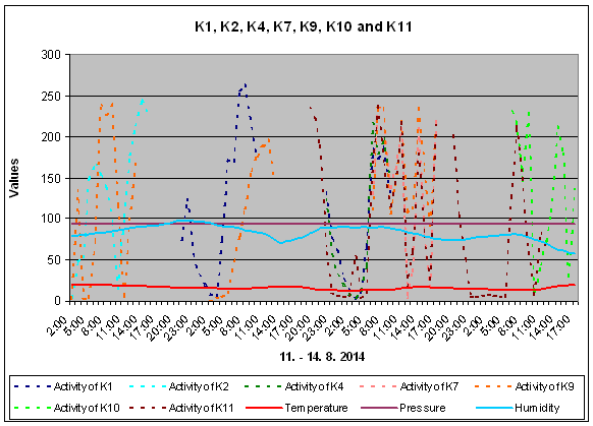

Figure No. 3: Physical activity of cows between 11 and 14 August 2014

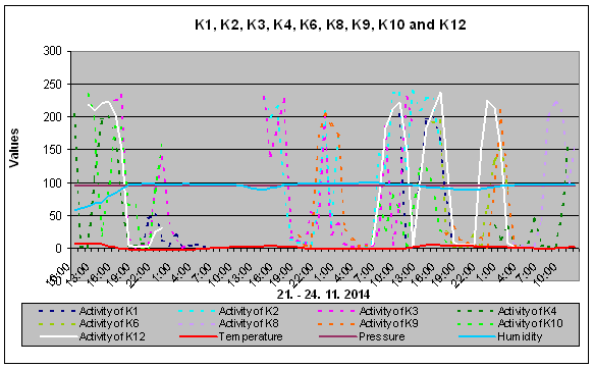

Figure No. 4: Physical activity of cows between 21 and 24 November 2014

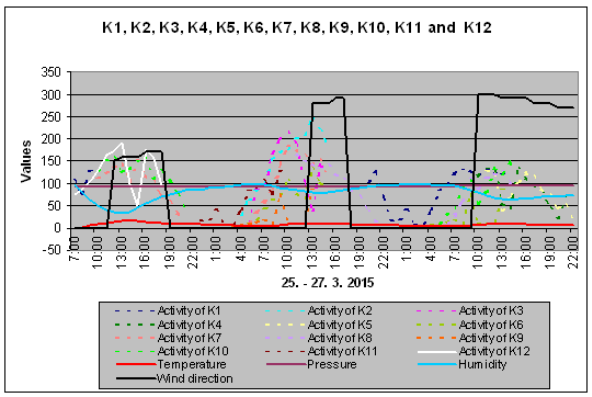

Figure No. 5: Physical activity of cows between 25 and 27 March 2015

Dependence of Physical Activity of the Cattle on the Daytime and Seasons

The physical activity of the monitored herd differs during the year as well as every day. The highest values of the cattle´s physical activity were observed in the summer and autumn months (see Figures No. 3 and 4). On the other hand, the lowest physical activity was in spring (see Figures No. 1 and 5). The similar conclusion was also made in the study by Voříšková (2001).

The cattle mostly have two to three main grazing periods every day. There are also a few minor grazing periods, the number of which varies (Voříšková, 2001). The first main grazing period starts immediately at daybreak. It, therefore, depends on the length of the day. In the winter months, another main grazing period in the afternoon can be observed. If the afternoon period lasts by 3 p.m., there may be another grazing period around 8 p.m. (see Figure No. 4). In the summer months, the beginning of the afternoon grazing period is shifted to 4 p.m. and grazing lasts until the sunset (Veselovský, 2005). Its duration, beginning and end, thus, depend on the day length.

Dependence of Physical Activity of the Cattle on Individual Meteorological Factors

The entire monitoring of the cattle´s physical activity makes it clear that the bovine animals are most influenced by the day length. This is also closely related to air temperature, as in the summer days the air temperature is highest in a year. If the air temperature exceeds 25 °C, the physical activity of the cattle drops, as also evidenced by Young (1981).

Atmospheric precipitations do not have a demonstrable effect on the cattle´s behaviour. This is apparently due to the fact that the monitored farm rears the meat bovine breeds being more resistant to weather. During the monitoring period, we did not record such an intensive precipitation which would have resulted in an increased physical activity and made the animals run to hide quickly.

Relative air humidity is one of the most changeable meteorological variables. Any relation between it and the physical activity, however, was not proven.

By contrast, the atmospheric pressure, does not change so much. It affects the cattle´s behaviour only where the atmospheric pressure changes more significantly (Šoch, 2005). And this happens, for instance, before the storm or after the rainfall. One can, however, assume that if the temperatures are lower and it is rainy, the cattle will restrict the movement outside the cowshed since otherwise there will be high heat losses from the cattle´s body surface. In this case, the activity will increase sharply after the atmospheric precipitations end, which is also caused by the atmospheric pressure, or more precisely, its rise.

The solar radiation affects the cattle in combination with the air temperature. In the summer days with a high intensity of insolation and the higher air temperature, the cattle´s movement is restricted and the animals gather in the cowshed or under the trees (Mitlöhner, 2001). In the midday and/or early afternoon hours, the physical activity drops. During these days, the cattle continued to graze later by the evening.

Velocity and direction of air flow have no significant effect on the cattle´s behaviour. The exception is only the period with the temperate below 5 °C and the relative air humidity above 80 %. Under these circumstances, the temperature is considerably transferred from the animal body surface and the animals start to be threatened by the cold stress (Mader, 1997). This combination, however, occurs especially in winter when the cattle are chased away to the wintering grounds where they have enough feed.

CONCLUSION

The physical activity of the monitored herd differs during the year as well as the day. It is also affected by the bovine breed and the technology of stalling. This experiment included the meat bovine breeds only. When the cattle were on the wintering grounds, their activity was lower.

The influence of meteorological variables on the cattle´s movement is low. The cattle´s activity depends on the daytime and the day length, in particular. The maximum activity is during the main grazing periods, i.e. at daybreak and in the afternoon. On the other hand, in case of the high relative humidity, longer atmospheric precipitations and the higher velocity of air flow, the activity is lower.

The state of health of the observed herd was mediocre. No unusual zoohygienic or veterinary complications were reported. It is therefore concluded that the given bovine breeds thrive in the local conditions and achieve the optimal performance.

Measurement and evaluation of individual meteorological factors should be one of the criteria in choosing the bovine breed.

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