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The behaviour of calves in innovative rooms of open housing

Zachowanie się cieląt w innowacyjnych pomieszczeniach typu otwartego

Summary. The purpose of research was to determine the influence of microclimatic conditions and age on the behaviour of calves in the innovative open housing- "village for calves". Calves were kept in group pens made from group boxes of "igloo" type and paddocks. Group K consisted of calves kept in summer (n = 20), and Group D of calves in winter (n = 20). In group pens microclimate studies were performed, and calves were observed from ethological point of view for 24-hours. Based on obtained results a significant influence of microclimate on the time calves lied down in individual parts of pen group was shown, that is, in the box or on the paddock. The main factors of micro-climate determining the place to lie down in the pen was the speed of air movement in the first place and then air temperature. Calves younger both in summer and winter laid longer in the boxes than older calves. In technological system "village for calves" the use of boxes of "igloo" type protects calves from adverse effects of weather conditions, which is particularly important in winter.

Key words: calves, open housing, microclimate of air, ethology

INTRODUCTION

Comfortable living of calves depends mainly on maintenance conditions including, among other things, the scope of the freedom of movement, type of floor or ground, equipment and microclimate conditions of buildings, which play a much greater role in maintaining the calves than in maintaining other groups of cattle [Kaczor and Mandrecki 2014]. In their studies Tschanz [1985] and Guth and Bockisch [1997] demonstrated that animals react with their behaviour to certain maintenance conditions. When the optimal

air temperature is exceeded or reduced the cattle reacts with the change in physiological processes or changed behaviour [Berman *et al.* 1985]. An additional factor, which largely determines the behaviour of calves is the age [Kaczor 2000]. Therefore, when assessing maintenance conditions of calves ethological research should be carried out. Microclimatic adverse conditions intensify the activity of pathogenic bacteria, which, first of all, cause diseases of respiratory system. The basic problem of the air exchange system in calf-houses, especially of traditional type, is to provide large amounts of air at low flow rates. High speed of air movement is particularly dangerous for calves at low temperature, high humidity and a high concentration of harmful gases in the air CO₂ and NH₃. With the minimizing risk of the transmission of infection in calves, we have to deal with individual maintenance in external boxes of "igloo" type where the air is not contaminated by microorganisms, dust and harmful gases and has a positive effect on health condition and weight gain [Richter and Karrer 2006, Albers 2008]. A beneficial effect on the animal health has also the factor of "hardening" the calves. However, in our climatic conditions, with extremely low air temperatures in winter, outdoor boxes do not fulfil their task. In addition, the maintenance of animals in outdoor boxes is associated with the deterioration of working conditions of service team in the period of adverse weather conditions. For this reason, new solutions of the open type housing are sought in the direction of improving the micro-climatic conditions for calves and the comfort of service team.

The purpose of research was to determine the influence of microclimatic conditions in summer and winter and the age on the behaviour of calves and the assessment of the usefulness of group boxes of "igloo" type in the technological system "village for calves".

MATERIALS AND METHODS

The experiment was performed on 40 calves of Holstein-Friesian breed black and white variety kept in innovative calf-house "village for calves" on the farm of cattle belonging to the horse stud "Nowe Jankowice" Ltd. (phot. 1). In the classic system of rearing the calves in igloo boxes in the open space canopy is not used and the distribution of boxes does not form technological system which is characteristic for livestock buildings. Boxes of "igloo" type sometimes called houses for the calves are made of plastic. The essence of the innovation of project "village for calves" was the use of appropriate technological system of the arrangement of boxes for individual and group igloo boxes, and the construction of open umbrella roof over the feed corridor and paddocks of boxes. On the one side of feed corridor "village for calves" 26 individual boxes were located with paddocks, and on the other 7 group boxes with 10 calves each, also with paddocks (phot. 2). Group boxes with paddocks formed group pens "village for calves". Open side walls over the boxes and gable walls in winter were covered with wind meshes. Group boxes with paddocks formed group pens "village for calves". The boxes were littered with straw. In individual boxes calves were kept from birth to approx. 3 weeks of age and then they were moved to group boxes, where they were kept up to 90 days of age. The experiment was performed on calves kept in group boxes with paddocks in summer (n = 20) and winter (n = 20). Both in summer and in winter the calves stayed in two group boxes with paddocks (10 calves). Calves kept in summer were marked with symbol K, while in winter with symbol D. Feeding of calves in groups K and D was identical, according to

the scheme accepted on the farm. Up to 30 days of age calves were fed with full milk mixed with milk-substitute preparation Mlekowit and received a start mixture formed from Kals Starter concentrate and whole corn grain. From 31 to about 90 days of age the calves were fed with drink mixture from the preparation of substitute milk Vitalac S-flaxseed-8 l/day of liquid feed during the early feeding and 4 l/day before weaning, with an initial content of 100 g of preparation per litre of water and the final one 25 g/litre of water. The calves received a start mixture 0.5 kg/day during the initial period of feeding with drink mixture and 1.8 kg/day before weaning.



Phot. 1. "Village for calves" in summer
Fot. 1. „Wioska dla cieląt” w okresie letnim



Phot. 2. Group boxes with paddocks and feed corridor
Fot. 2. Budki grupowe z wybiegami i korytarz pasowy

In groups microclimate measurements were taken and ethological observations.

During ethological observation continuous measurements of the temperature and relative humidity of the air were recorded using electronic devices of apparatus Data logger S3121 (Comet, Czech Republic). Data loggers were installed in the box and on the paddock. In addition, momentary measurements of the speed of air movement on the paddock and in the box were taken at two heights, that is, the animal lying and standing (10 cm and 70 cm above the surface of litter). Research was performed at 07:00, 14:00 and 21:00 using the device Testo 445-2 (Testo AG, Germany) according to the generally accepted rules in this type of research [Pilarczyk, 1987]. Using industrial video cameras 24-hour ethological observations of 10 calves at the age of 28 (calves 1-month) and 10 calves at the age of 86 days \pm 3 days (calves 3-months) were made. Observations were made both in summer and in winter. The study included the following forms of behaviour (actions) of calves: lying on the paddock, lying in the box, standing on the paddock, concentrated feed intake, water and drink mixture consumption. Standing included walking and running. Readout of video tapes with the film recording was carried out in 10 minutes intervals.

Results of ethological research were developed statistically by using the one-way analysis of variance and Scheffe's test, Statistica v. 9.0. [StatSoft Inc. 2009].

RESULTS

Test results of the microclimate of air in individual parts of the group pen "village for calves" in summer and in winter are shown in table 1.

Table 1. Mean daily values of the parameters of microclimate in individual parts of the group pen "village for calves" (\bar{x})

Tabela 1. Średnie dobowe wartości parametrów mikroklimatu w poszczególnych częściach kojca grupowego „wioski dla cieląt” (\bar{x})

Trait Cecha	Group/Grupa			
	K		D	
	paddock wybieg	box budka	paddock wybieg	box budka
Air temperature Temperatura powietrza (C°)	22.4	22.9	-2.5	-1.8
Relative humidity Wilgotność względna (%)	54.3	58.1	66.4	72.3
Speed of air movement Prędkość ruchu powietrza (m/s)	0.55	0.09	0.26	0.07

K – the summer period/ okres letni

D – the winter period/ okres zimowy

Comparing the temperature of the air in the "village for calves" in summer and in winter significant differences were found. The temperature of the air on the paddock and in the box in summer (group K) was around 25°C higher than in winter (group D). In contrast, the average daily air temperature within the pen, that is, on the paddock and in the box both in winter and in summer was similar. Similarly, was the daily average rela-

tive humidity of air within the pen. Taking into account the season of the year, relative air humidity on the paddock in winter (group K) was about 12 percentage points (p.p.) higher than in summer (group D) and in the box about 14 p.p. The biggest differences between the values of the parameters of microclimate on the paddock and in the box were recorded as regards the speed of air movement. Average daily air speed on the paddock in summer and winter was higher 0.45 m/s and 0.19 m/s respectively from the average daily air speed movement in the box. The speed of air movement on the paddock in summer (group K) was 0.29 m/s higher than in winter (group D), while in the boxes in summer and in winter it was similar.

The results of ethological research involving average values of the duration of basic activities of calves 1-and 3-months during the day are shown in tables 2 and 3.

Table 2. The average time of different activities of 1-month calves during a day ($\bar{x} \pm SE$)
Tabela 2. Średni czas poszczególnych czynności 1-miesięcznych cieląt w ciągu doby ($\bar{x} \pm SE$)

Specification Wyszczególnienie	Group/Grupa	
	K	D
Lying/ Leżenie (min)	1008 \pm 76.30	1016 \pm 75.25
– on the paddock/ na wybiegu	467 \pm 27.36 A	170 \pm 22.80 B
– in the box/ w budce	541 A \pm 45.12	846 B \pm 67.92
Standing/ Stanie (min)	360 \pm 47.71	343 \pm 44.61
– on the paddock/ na wybiegu*	307 \pm 40.32	303 \pm 41.52
– in the box/ w budce	53 \pm 8.40	40 \pm 10.08
Feed intake/ Pobieranie paszy (min)	29 \pm 6.96	42 \pm 14.64
Drinking water/ Pobieranie wody (min)	23 \pm 7.68	19 \pm 6.48
Drink mixture intake/ Pobieranie pójła (min)	20 \pm 13.92	20 \pm 13.92

* The action of standing on the paddock also applies to the movement of calves on the paddock/
Czynność stanie na wybiegu dotyczy również poruszania się cieląt po wybiegu

K – the summer period/ okres letni

D – the winter period/ okres zimowy

A, B – values in rows with different letters differ significantly ($p \leq 0.01$)/ wartości w wierszach oznaczone różnymi literami różnią się istotnie ($p \leq 0,01$)

The average daily time of 1-month calves lying time in summer (group K) and in winter (group D) was similar and it was 1008 and 1016 minutes respectively, that is, about 70% of daytime (table 2). However, statistically significant differences in the time of lying of calves in individual parts of the pen, that is, on the paddock and in the box were found. Calves in group D as compared to group K laid a shorter time on the paddock about 297 min. (64%) ($p \leq 0.01$) while in the box they laid longer by 305 minutes. (56%) box ($p \leq 0.01$). Having regard only to the season of the year, in summer the time of calves laying down on the paddock was 44% and in boxes 66% of the total time of lying down during the day. In winter the calves laid on the paddock only 17%, and in boxes 83% of the total time of lying down during the day. The average daily time of the standing of calves in groups K and D was similar and ranged from 343 to 360 minutes, that is, about 25% of the day (table 2). Similarly, the time of standing of calves in group

K and D only on the paddock was similar. In the box calves in group D stood a shorter time of about 13 minutes. (24%) than calves in group D but these differences were not significant statistically. The average daily time of the feed intake by calves in group D was about 13 minutes (31%) longer than in calves in group K, and the time of drinking water was similar. There were no significant differences between average time of intaking the feed by calves in groups K and D. The average daily time of intaking milk by calves in groups K and D was the same.

Table 3. The average time of different activities of 3-months calves during a day ($\bar{x} \pm SE$)
Tabela 3. Średni czas poszczególnych czynności 3-miesięcznych cieląt w ciągu doby ($\bar{x} \pm SE$)

Specification Wyszczególnienie	Group/ Grupa	
	K	D
Lying/ Leżenie (min)	901 \pm 72,34	889 \pm 68,38
– on the paddock/ na wybiegu	835 \pm 60,48 A	321 \pm 34,56 B
– in the box/ w	66 \pm 16,56 A	568 \pm 81,84 B
Standing/ Stanie (min)	350 \pm 44,11	358 \pm 49,8
– on the paddock/ na wybiegu*	341 \pm 43,92	331 \pm 48,00
– in the box/ w budce	9 \pm 2,64	27 \pm 8,64
Feed intake (min.)	140 \pm 2,28	153 \pm 43,2
Pobieranie paszy (min)		
Drinking water (min.)	29 \pm 7,44	20 \pm 7,68
Pobieranie wody (min)		
Drink mixture intake (min.)	20 \pm 13,68	20 \pm 13,68
Pobieranie pólka (min)		

* The action of standing on the paddock also applies to the movement of calves on the paddock/
Czynność stanie na wybiegu dotyczy również poruszania się cieląt po wybiegu

K – the summer period/ okres letni

D – the winter period/ okres zimowy

A, B – values in rows with different letters differ significantly ($p \leq 0.01$)/ wartości w wierszach oznaczone różnymi literami różnią się istotnie ($p \leq 0,01$)

The average daily time of laying of 3-months calves in the summer (group K) and in the winter (group D) was similar and were 901 and 889 min respectively. that is approximately 62% of the time of day (table 3). However, statistically significant differences in the time of calves lying in individual parts of the pen was found. Calves in group D laid on the paddock 514 min. (62%) shorter than calves in group K ($p \leq 0.01$), but they laid longer 502 min (760%) in the box ($p \leq 0.01$). Taking into account only the time of the year, in summer calves laid on the paddock 93% and in winter, only 36% of the total time of lying during the day. The average daily time of the standing of calves in groups K and D was similar and it ranged respectively 350 and 358 min. that is, about 25% of the time of day (table 3). Similarly, the average time of the standing of calves in group K and D only on the paddock was similar. Calves in group D stood in the box longer about 18 min. (66%) than calves in group K, however, there was no statistically significant differences in the time of the standing of calves in group K and D. The average daily time of feed intake by calves in group D was about 13 minutes (8%) longer than calves in group K, and the time of taking water by 9 min. (31%) shorter, but these differences were not significant statistically.

DISCUSSION

Microclimatic conditions in the open type housing in terms of temperature and air humidity are similar to external climatic conditions. And the speed of air movement in this kind of rooms depends first of all on the degree of the opening of side walls and possibility to cover them in the period of adverse weather conditions [Kaczor and Mandrecki 2014]. An important difficulty in assessing microclimatic conditions is the lack of standards for cattle in these type of housing. Only recommended values are provided, which are the result of research and experience from practice. For this reason, microclimatic conditions in group pens "village for calves" were compared to the applicable standards in traditional calf-houses. In one's own studies the daily average temperature on the paddock and in the group box of "igloo" type during ethological observations in summer corresponded to standards for this category of animals – temperature from 8 to 25°C [IZ 1977]. And the air temperature in winter on the paddock (-2.5°C) and in boxes (-1.8°C) was lower than the recommended standards. Some authors point to the good effects of rearing the calves in the open type housing at low temperatures [Van Cae-negem 2006, Albers 2008]. According to Ruckebusch [1990] the bottom critical temperature of air for calves should not exceed -20°C, and the top one 40°C. Relative air humidity on the paddock and in the box, both in summer and winter was similar to optimal values in keeping the calves, from 60 to 80% [IZ 1977, AEL 2007]. The air temperatures within the group pen "village for calves", that is, on the paddock and in the box in summer were similar. In winter, also the air temperature on the paddock and in box was also similar. The factor differentiating the paddock and box from the microclimate point of view was the speed of air movement. On the paddocks the speed of air in summer was 6 times in winter 4 times higher than in the boxes. The reduction of the speed of air movement on the paddocks in winter could be achieved using wind meshes on the side and gable walls of "village for calves", which were open in summer. According to the information card IZ [1977] the speed of air movement to keep calves should not exceed 0.2 m/s in winter and 0.3 m/s in summer, while the German standards [DIN 18910] report limit value in winter 0.2 m/s in summer even up to 0.6 m/s [AEL 2007]. In the boxes, this parameter microclimate reached low values not exceeding 0.1 m/s.

Varied microclimatic conditions did not influence significantly the general time of lying for 1-month and 3-months calves during the day. This time depended on age. 1-month calves rested about 100 minutes longer than the older ones. Similar results in the studies of the behaviour of calves were received by Kaczor and Kaczor [2016]. In one's own studies the overall time of the lying of 3-months calves within 24 hours was reduced in favour of the increased time for the feed intake. As we know, older calves intake more feed and thus spend more time to do it. A similar trend in the behaviour of calves was found by Kaczor and Szyndler [1997] and Kaczor [2000]. The overall time of standing, intaking the drink mixture and water by 1-month calves during the day was similar to 3-months calves. A significant impact of microclimate on time of lying of calves in individual parts of the pen was found. The studies carried out were a particular test of the selection of place to lie down. In summer, the calves preferred leisure on the paddock, where they had 2.5 times more surface area to lie down at disposal than in the box. In winter, however, the calves rested mainly in the box where 10 calves could lie at the same time. In this context it seems that the main factors determining the choice of place

to lie down in the pen was the speed of air movement in the first instance and then temperature. The animals stayed in the pen in two different zones in terms of the value of the speed of air movement. On the paddock the speed of air movement, especially in summer was significantly greater than in the box. High speed of air increases the heat dissipation by the body as convection [Janowski 1978, Kaczor *et. al.* 2015]. In summer, the increased speed of air prevents the heat stress and in winter causes excessive hypothermia of the body of animals. It can be assumed that at extremely low temperatures of the air the time of calves staying in the boxes would be even longer. The extent of the use of boxes for lying down by the calves depended also on age. Younger calves both in summer and in winter laid longer in the boxes than older calves. Varied micro-climatic conditions in summer and in winter did not have a significant impact on the time of standing, the feed intake, water and drink mixture consumption.

CONCLUSIONS

The following conclusions and statements have been formulated on the basis of research performed:

1. Varied micro-climatic conditions in summer and in winter did not affect the overall time of lying, standing, the feed intake, water and drink mixture by calves during the day which were kept in group pens of "village for calves".

2. A significant impact of microclimatic conditions on the choice and time of calves lying in individual parts of the group pen, that is, on the paddock or in the "igloo" box, and the main factors determining the choice of place to lie down was the speed of the air movement and temperature.

3. The extent of the use of boxes to lie down depended also on the age of calves. Younger animals laid in the boxes both in summer and in winter, and older calves preferred to take a rest mostly in winter.

4. In the technological system of "village for calves" the use of boxes of "igloo" type protects calves from the effects of adverse weather conditions, which is particularly important in winter.

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Streszczenie. Celem badań było określenie wpływu zróżnicowanych warunków mikroklimatycznych oraz wieku na zachowanie się cieląt w innowacyjnym pomieszczeniu otwartym typu „wioska dla cieląt”. Cielęta były utrzymywane w kojcach grupowych, utworzonych z budek grupowych typu „igloo” i wybiegów w okresie letnim (grupa K, n = 20) i zimowym (grupa D, n = 20). W kojcach grupowych wykonano badania mikroklimatyczne, a na cielętach przeprowadzono 24-godzinne obserwacje etologiczne. Na podstawie uzyskanych wyników badań wykazano istotny wpływ mikroklimatu na czas leżenia cieląt w poszczególnych częściach kojca grupowego, tj. w budce lub na wybiegu. Czynnikiem mikroklimatu decydującym o wyborze miejsca do leżenia w kojcu były w pierwszej kolejności prędkość ruchu powietrza, a następnie temperatura powietrza. Cielęta młodsze zarówno w okresie letnim, jak i zimowym dłużej leżały w budkach niż cielęta starsze. W układzie technologicznym „wioski dla cieląt” stosowanie budek typu „igloo” zabezpiecza cielęta przed oddziaływaniem niekorzystnych warunków atmosferycznych, co jest szczególnie istotne w okresie zimowym.

Słowa kluczowe: cielęta, pomieszczenia otwarte, mikroklimat powietrza, etologia