FOLIA POMERANAE UNIVERSITATIS TECHNOLOGIAE STETINENSIS
Folia Pomer. Univ. Technol. Stetin., Agric., Aliment., Pisc., Zootech. 2014, 312(31), 39–48

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THE EFFECT OF THE COW UPKEEP SYSTEM ON SELECTED PHYSICAL PARAMETERS OF THE COWSHED MICROCLIMATE

WPŁYW SYSTEMU UTRZYMANIA KRÓW NA KSZTAŁTOWANIE SIĘ WYBRANYCH PARAMETRÓW FIZYCZNYCH MIKROKLIMATU W OBORACH

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Streszczenie. Porównano wybrane parametry fizyczne mikroklimatu w oborach o zróżnicowanych systemach utrzymania krów. Materiał badawczy stanowiły 4 obory (A, B, C i D) zlokalizowane w województwie mazowieckim. W oborach A i B liczba krów była zbliżona (A – 24 krowy, B – 26 krów). W obiektach tych krowy utrzymywane były w systemie uwięziowym. W oborach C i D liczba krów wynosiła odpowiednio 100 i 60. W budynkach tych krowy utrzymywano w systemie wolnostanowiskowym. Przeprowadzone badania obejmowały inwentaryzację zoohigieniczną obór i ocenę wybranych parametrów fizycznych mikroklimatu w okresach zimowym i wiosennym. Kubatura pomieszczeń, w przeliczeniu na zwierzę, w obiektach A i B w niewielkim stopniu odbiegała od zalecanych norm zootechnicznych, natomiast w oborach C i D wskaźnik ten był przekroczony ponad 5-krotnie. Korzystniejsze warunki mikroklimatyczne odnotowano w oborach uwięziowych, przy czym lepsze dla dobrostanu krów są obory wolnostanowiskowe. W oborach wolnostanowiskowych wykazano w okresie zimowym zbyt małe wartości minimalnej temperatury powietrza w stosunku do norm zoohigienicznych. Wilgotność względna powietrza w okresie zimowym we wszystkich badanych oborach była zbliżona (od 70,0 do 88,8%). Zimą w oborach B, C i D prędkość ruchu powietrza mieściła się w zalecanej normie, natomiast w oborze A wykazano przekroczenie tego parametru (wartości maksymalne). W budynku A warunki ochładzania w okresach zimy i wiosny odbiegały minimalnie od zalecanego optimum dla krów mlecznych. Współczynnik oświetlenia naturalnego (O : P) wynosił od 1 : 7 w oborze D do 1 : 107 w oborze B. W budynku B współczynnik oświetlenia naturalnego był za niski, spowodowany małą liczbą okien. Stwierdzone w badanych obiektach natężenie oświetlenia naturalnego i sztucznego było zgodne z normami zootechnicznymi.

Key words: dairy cattle farms, physical parameters of microclimate, upkeep system, welfare animals.
Słowa kluczowe: dobrostan zwierząt, fermy bydła mlecznego, parametry fizyczne mikroklimatu, systemy utrzymania.

INTRODUCTION

The farming environment has a significant effect on animal production efficiency and product quality (Iwańczuk-Czernik 1997). Inadequate zoohygienic conditions and animal care considerably impair production results. As a consequence of long-term and targeted breeding efforts, farm animals, including milk cows, have developed a high genetic potential

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which enables the breeder to obtain high milk yields (Kupczyński and Chudoba-Drozdowska 2000). The use of the genetic potential of the animals is possible after a well-balanced diet and optimal environmental conditions have been ensured (Kamieniecki et al. 1998; Kołacz and Bodak 1999; Bombik et al. 2011). The rise in the performance and milking capacity of the animals is closely connected with higher subsistence requirements to be met by the breeder. A change of the animal keeping system can result in improvements in welfare, state of health and output (Bieda and Herbut 2007).

The study was aimed at comparing selected physical microclimate parameters in cowsheds with different keeping systems.

MATERIAL AND METODS

The experimental material was constituted by four cowsheds (A, B, C and D) located in the Masovian Voivodeship. The sheds differed in the number of the cows and the keeping system. In two sheds (A and B), located in the Huszlew Commune, the numbers of the cows were similar: 24 and 26 heads, respectively. The cows in these sheds were kept using the stanchion system. In the two other sheds (C and D), located in the Olszanka Commune, the numbers of the cows were different: 100 and 60 heads, respectively. The cows in these sheds were kept in the loose system, the difference consisting in that in shed C, the cows did not have separate beddings (deep bedding base), whereas in shed D, each cow had a separate box with a shallow bedding base.

The study included a zoohygienic inspection of the cowsheds and an assessment of the microclimatic conditions in the rooms in which the cows were kept.

The zoohygienic inspection involved the following measurements: cowshed dimensions and topographical location; stall and box dimensions; numbers, sizes and arrangement of the windows type of artificial lighting; and the cow keeping system.

Based on the inspection, we calculated the area-cubature indices for the rooms. Additionally, using indirect methods, we assessed the natural lighting, by determining the window glass to floor area ratio (O : P), and the artificial lighting ($W \cdot m^{-2}$). The zoohygienic inspection was performed according to the methodology described by Janowski (1979) and Keśla (2011). The measurements of the zoohygienic parameters were made in the winter and spring periods three times a day (at 10 : 00 AM, 02:00 PM and 09 : 00 PM). The measurements were taken at the wither height for 2 weeks, on days typical of the season of the year (at the lowest outside temperatures). The following physical air parameters were measured: temperature and relative humidity, air movement and cooling, as well as natural lighting intensity. Air temperature and relative humidity were identified using a COMET D3121 hytherograph, while cooling was measured with a dry Kata thermometer. Natural and artificial lighting of the cowsheds was measured with an HD 9221 illumination meter that registers lighting intensity in luxes (lx).

The obtained results were juxtaposed as extreme values (the minimum and maximum), arithmetical means ($\bar{x}$) and variation coefficients (V%). These values were calculated for the following physical parameters of the air: temperature and relative humidity, air movement speed and cooling for each cowshed (A, B, C and D), allowing for two seasons of the year (winter and spring). The statistical indices were calculated following Trętowski and Wójcik (1991).

RESULTS AND DISCUSSION

The cowsheds selected for the analyses differed in the cattle keeping system, numerical strength, floorspace and cubature, as well as window sizes and numbers.

Table 1 contains the area-cubature indices for the cowsheds. The floorspace areas per 1 cow were diverse, ranging from 8.6 $m^2 \cdot head^{-1}$ (cowshed B) to 16.0 $m^2 \cdot head^{-1}$ (cowshed A). The cubature index had the lowest value in cowshed B (29.4 $m^3 \cdot head^{-1}$), and the highest in shed C and D (118.7 and 113.3 $m^3 \cdot head^{-1}$). The shed cubature per 1 cow in cowsheds A and B slightly exceeded the recommended zootechnical standards. Rokicki and Kolbuszewski (1999) have reported that, in the case of milk cows, this index should amount to approximately 15–22 $m^3 \cdot head^{-1}$. On the other hand, in sheds C and D, the recommended standards were exceeded more than fivefold. However, this is not an objective index, since cowsheds C and D had flat roofs.

Table 1. Area-cubature indexes of analyzed cowsheds
Tabela 1. Wskaźniki powierzchniowo-kubaturowe badanych obór

Specification – Wyszczególnienie	Cowshed – Obora			
	A	B	C	D
Building measurements Wymiary budynku [m]				
length – długość	32.0	25.0	50.0	40.0
width – szerokość	12.0	9.0	25.0	17.0
height – wysokość	3.1	3.4	9.5	10.0
Indexes – Wskaźniki				
area [$m^2 \cdot head^{-1}$] powierzchniowe [$m^2 \cdot szt.^{-1}$]	16.0	8.6	12.5	11.3
cubature [$m^3 \cdot head^{-1}$] kubaturowe [$m^3 \cdot szt.^{-1}$]	49.6	29.4	118.7	113.3

The stall size in cowsheds A and B ranged from 1.10m in width and 1.65m in length. The stalls were constructed in a two-row arrangement. According to Rokicki and Kolbuszewski (1999) and Wyszyński (2002), such stall dimensions are adequate and in line with zoohygienic standards. Shed C did not contain separate stalls. The resting area per 1 cow in this cowshed was 12.5 m^2. Wyszyński (2002) has reported that the minimal resting area should range from 2.5 to 5.0 $m^2 \cdot head^{-1}$. Cowshed D contained 1.15m x 2.15m (W x L) boxes. According to Wyszyński (2002), such box dimensions in loose barns comply with recommended zootechnical standards.

Table 2 contains a juxtaposition of values of air temperature in the analysed cowsheds in the winter and spring periods. The winter air temperatures ranged from 4.2ºC in shed C to 13.5ºC in shed B. In spring, this parameter assumed values ranging from 9.9ºC (shed D) to 18.3ºC (shed A). It should be emphasized that the lowest winter air temperature was recorded in the morning, and the highest in the evening. The spring minimal values of this parameter also refer to the morning time, and the maximal to the afternoon. According to Rokicki and Kolbuszewski's (1999) and Szulc and Rzeźnik's (2007) recommendations, the minimal air temperature for cows should not be lower than 6ºC, regardless of the keeping system; optimally: from 8ºC to 16ºC and maximally: up to 25ºC. Fiedorowicz and Mazur (2011) recommend a minimal air temperature of 8ºC for cows kept in a stanchion system, and 2ºC in loose barns.

Table 2. The values of the temperature [ºC] and air relative humidity [%] in the cowsheds in winter and spring period
Tabela 2. Wartości temperatury [ºC] i wilgotności względnej powietrza [%] w oborach w okresach zimowym i wiosennym

Parameters Parametry	Measurement places Miejsca pomiarowe	Statistical measures – Miary statystyczne		
		range – zakres	$\bar{x}$	V%
Air temperature Temperatura powietrza	winter – zima			
	A	6.8 – 10.1	8.4	11.9
	B	12.2 – 13.5	12.3	4.1
	C	4.2 – 8.3	6.8	13.2
	D	5.6 – 9.6	7.6	13.1
	spring – wiosna			
	A	11.0 – 18.3	14.1	20.6
	B	13.1 – 17.6	14.5	11.1
	C	10.3 – 14.6	12.2	13.1
	D	9.9 – 14.4	12.3	13.1
Air relative humidity Wilgotność względna powietrza	winter – zima			
	A	77.3 – 88.8	82.3	3.5
	B	77.6 – 88.8	79.9	4.4
	C	70.0 – 88.0	80.7	5.9
	D	71.1 – 88.7	79.6	6.5
	spring – wiosna			
	A	36.6 – 68.5	57.5	9.3
	B	38.8 – 63.3	52.7	18.2
	C	47.0 – 75.9	64.8	12.1
	D	54.4 – 73.0	65.5	10.4

Explanations – Objaśnienia:
$\bar{x}$ – arithmetic mean – średnia arytmetyczna.
V% – coefficient of variation – współczynnik zmienności.

Neja and Bogucki (2007) have reported that in an environment with the air temperature of approximately 35ºC, cow output diminishes, whereas at excessively low temperatures, feed consumption and milk fat content rise. In cowsheds A and B, the minimal air temperature was within the bounds of the optimal zootechnical standards reported by the abovementioned authors. On the other hand, in cowsheds C and D, this parameter slightly diverged from the recommended standards. In spring, the air temperature in all the analysed cowsheds assumed standard values referred to by a number of authors. Excessively high temperatures in the cowshed are more detrimental to cows than excessively low temperatures (Rabek et al. 1984; Rokicki and Kolbuszewski 1999; Szulc and Rzeźnik 2007; Neja and Bogucki 2007). Our air temperature measurements in the analysed cowsheds show that the warmest building was cowshed B. The winter air temperature in this building had the lowest variation coefficient (4.1%). In the other buildings (A, C and D), the variation coefficient assumed similar values (from 11.9% to 13.2%). The spring variation coefficient, calculated for air temperature, ranged from 11.1% in cowshed B to 20.6% in cowshed A. The evaluation of the obtained air temperature results in relation to cow welfare shows a slight deviation from the recommended air temperature only in winter in cowsheds C and D. In spring, advantageous thermic conditions prevailed in all the analysed cowsheds, positively and considerably influencing cow welfare.

The values for relative air humidity inside the cowsheds (in winter and in spring) and the results of statistical calculations are presented in Table 2. Relative air humidity in the winter period was similar in all the cowsheds and ranged from 70.0% to 88.8%. The highest relative humidity was observed in the morning, slightly lower in the evening, an the lowest at noon. In spring, considering the warmth of the season of the year, air humidity was much lower, ranging from 36.6% in cowshed A to 75.9% in cowshed C. The lowest relative air humidity was recorded at noon, and the highest in the morning. The analysis of the relative air humidity results in the winter period revealed that the minimal and maximal values were slightly exceeded in all the analysed cowsheds. In the spring period, we recorded substantially lower relative humidity values in all the barns. However, in spring, this index did not exceed the relative air humidity levels set out in the zoohygienic standards (Fiedorowicz and Mazur 2011). As reported by Rokicki and Kolbuszewski (1999), optimal relative air humidity at 8–16ºC should range from 60% to 80%. At the maximal temperature of 25ºC, in turn, this parameter should amount to 85%. Szulc and Rzeźnik (2007) have reported that elevated air humidity in winter intensifies the feeling of the cold. At the optimal air temperature (approximately 15ºC), the optimal relative air humidity in cowsheds should be approximately 75%. High temperature and low air humidity, in turn, cause the mucous membranes of the animals to dry up and crack, making them more susceptible to infections. In winter, the lowest relative air humidity correlation coefficient was identified in cowshed A (3.5%), and the highest in cowshed D (6.5%). In spring, the correlation coefficient assumed slightly higher values, ranging from 9.3% in building A to 18.2% in building B. It must be emphasized that both air temperature variation and relative humidity changes were very low, which testifies to a very good heat-insulation of the cowsheds.

The air movement speed and cooling values in the winter and spring periods in the barns are presented in Table 3. In winter, extreme air movement speeds ranged from 0.03 $m \cdot s^{-1}$ in cowshed D to 0.64 $m \cdot s^{-1}$ in cowshed A. In spring, this parameter assumed values from 0.03 $m \cdot s^{-1}$ in cowshed A, B and C to 15.00 $m \cdot s^{-1}$ in cowshed D. According to Kołacz and Dobrzański (2006) and Fiedorowicz and Mazur (2011), air movement speed in buildings intended for cattle should range from 0.1 to 0.3 $m \cdot s^{-1}$ in winter and to 0.5 $m \cdot s^{-1}$ in summer. In winter, air movement speeds in cowsheds B, C and D were within the recommended standard range, whereas in cowshed A, this parameter was too high in comparison with the zoohygienic standards. In spring, correct air movement was observed only in building A. On the other hand, we recorded high air movement values in cowsheds B and C (7.30 and 15.0 $m \cdot s^{-1}$, respectively), defined as strong wind. Such high values of this parameter were caused by the fact that the gates in the opposite sides of the buildings were open during the measurements, with a high wind outside, which generated high air movement speeds in the cowsheds, unbeneficial to the animals. The coefficient of variation in air movement speeds in the winter period ranged from 30.7% in building C to 107.1% in building A. In spring, the lowest coefficient of variation in air movement speeds was identified in cowshed A (50.0%), and the highest in cowshed C (111.7%).

Table 3. The values of the air movement [m · s^{-1}] and cooling power [mW · cm^{-2}] in the cowsheds in winter and spring period
Tabela 3. Wartości ruchu powietrza [m · s^{-1}] i ochładzania [mW · cm^{-2}] w oborach w okresach zimowym i wiosennym

Parameters Parametry	Measurement places Miejsca pomiarowe	Statistical measures – Miary statystyczne		
		range – zakres	$\bar{x}$	V%
Ruch powietrza Air movement	winter – zima			
	A	0.05 – 0.64	0.14	107.1
	B	0.05 – 0.20	0.08	100.0
	C	0.09 – 0.22	0.13	30.7
	D	0.03 – 0.22	0.13	46.1
	spring – wiosna			
	A	0.03 – 0.14	0.08	50.0
	B	0.03 – 1.00	0.29	106.8
	C	0.03 – 7.30	2.72	111.7
	D	0.30 – 15.00	5.68	97.3
Cooling power Ochładzanie	winter – zima			
	A	18.42 – 103.83	56.52	40.8
	B	30.56 – 75.78	51.08	35.2
	C	36.00 – 95.46	56.94	36.8
	D	34.75 – 91.69	55.68	36.8
	spring – wiosna			
	A	23.86 – 78.71	44.38	48.1
	B	25.12 – 116.39	51.92	50.9
	C	29.31 – 92.53	58.62	35.1
	D	39.78 – 111.79	71.18	28.2

Explanations as in Table 2.
Objaśnienia jak w tab. 2.

In winter, extreme cooling values ranged from 18.42 mW · cm^{-2} to 103.83 mW · cm^{-2} in cowshed A. In spring, this parameter assumed slightly higher values: from 23.86 mW · cm^{-2} in cowshed A to 116.39 mW · cm^{-2} in cowshed B. According to Rokicki and Kolbuszewski (1999) and Fiedorowicz and Mazur (2011), optimal cooling in barns for stanchioned milk cows should range from 27.21 mW · cm^{-2} to 35.59 mW · cm^{-2}, while in the case of loose barns: from 29.31 mW · cm^{-2} to 39.77 mW · cm^{-2}. Minimal winter and spring cooling values diverged from the recommended optimum in building A. Only the winter minimal cooling values complied with zoohygienic standards in cowshed B. Minimal winter and spring cooling values in buildings C and D were within the recommended standard range. Maximal winter and spring cooling values were significantly exceeded in all the analysed cowsheds, resulting in the animals possibly catching cold and overly losing body warmth. It must be pointed out that the values of cooling in the cowsheds were affected by the other analysed microclimate parameters (temperature, relative humidity and air movement speed). Variation in winter cooling in the analysed buildings assumed values ranging from 35.2% in cowshed B to 40.8% in cowshed A. In spring, the coefficient of variation in this parameter ranged from 28.2% (building D) to 50.9% (building B).

The natural and artificial lighting profiles of the barns in the winter and spring periods are presented in Table 4.

Table 4. The characteristic of natural and artificial lighting in the cowsheds in winter and spring period
Tabela 4. Charakterystyka oświetlenia naturalnego i sztucznego w oborach w okresach zimowym i wiosennym

Specification – Wyszczególnienie	Cowshed – Obora			
	A	B	C	D
Number of windows – Liczba okien	21	7	25	25
Windows measurements Wymiary okien [m] width – szerokość height – wysokość	 1.2 0.6	 0.6 0.5	 2.00 2.55	 2.00 2.55
Natural lighting (W : F) Oświetlenie naturalne (O : P)	1 : 22	1 : 107	1 : 10	1 : 7
Artificial lighting Oświetlenie sztuczne [$W \cdot m^{-2}$]	2.9	2.7	1.9	1.8
Lighting intensity (natural + artificial) Natężenie oświetlenia (naturalne + sztuczne) [lx] winter – zima spring – wiosna	 27.6 176.1	 22.9 178.6	 67.3 178.6	 55.3 146.0

Explanations – Objaśnienia: W : F – windows glass to floor area ratio – O : P – stosunek oszklonej powierzchni okien do powierzchni podłogi.

The numbers and sizes of the windows were different (ranging from 7 in cowshed B to 21 in cowshed A). In buildings C and D, skylights performed the function of windows (25 in each cowshed). The windows in cowsheds A and B tilted outside at the bottom and had one-piece panes in wooden frames. Rokicki and Kolbuszewski (1999) have reported that windows tilting inside at the top are the best solution, since the incoming air flow is not directed straight at the animals. Natural lighting in the analysed cowsheds was supplemented with glow lamps. The coefficient of natural lighting (O : P) ranged from 1 : 7 in cowshed D to 1 : 107 in cowshed B. According to Bombik and Kolbuszewski's (1995) recommendations, the window glass to floor area ratio should be 1:16 in the case of milk cows. The natural lighting coefficient in cowshed B was very low, due to a small window area. The artificial glow lamp lighting in the analysed buildings ranged from 1.8 $W \cdot m^{-2}$ in cowshed D to 2.9 $W \cdot m^{-2}$ in cowshed A. Rokicki and Kolbuszewski (1999) have reported that glow lamp intensity should be 4 $W \cdot m^{-2}$ in the case of milk cows. Room illumination does not only depend on the number and power of lamps but also on their positioning, as well as window sizes and how clean they are. The photoclimatic measurement results show that the mean values of lighting intensity in winter ranged from 27.6 lx in building A to 67.3 lx in building C. In the spring period, the analysed parameter ranged from 146.0 lx in cowshed D to 178.6 lx in cowsheds B and C. According to Rokicki and Kolbuszewski (1999) and Kaczor (2005), optimal lighting intensity should oscillate between 15 lx and 30 lx. On the other hand, Neja and Bogucki (2007b) have reported that the lighting of cowsheds should range from 20 lx to 30 lx. Fiedorowicz and Mazur (2011) recommend cowshed lighting intensity at between 25 lx and 100 lx, regardless of the cattle keeping system. The lighting intensity identified in the analysed barns complied with the recommended zootechnical standards.

RECAPITULATION

Summing up the study results, it must be noted that the milk cattle keeping conditions only slightly diverged from the optimal zoohygienic requirements as regards animal welfare. More advantageous microclimatic conditions were observed in the stanchion barns, whereas loose barns are a better solution as far as the comfort of milk cattle is concerned. Excessively low air temperature values in relation to the recommended zoohygienic standards were recorded in the loose barns. The minimal and maximal values of relative air humidity in the analysed cowsheds exceeded the optimal levels reported for milk cows. Variation in air temperature and air humidity remained at a very low level (3.5%–20.6%), which confirmed inconsiderable fluctuation of these parameters and adequate heat-insulation of the cowsheds. In winter, air movement speed in sheds B, C and D was within the recommended standard range, whereas in cowshed A, the parameter was found to be in excess of the maximal acceptable values. The minimal winter and spring cooling conditions in shed A diverged from the recommended optimum for milk cows. The natural lighting coefficient in cowshed B was too low, due to a small window area. The natural and artificial lighting intensities in the analysed buildings complied with zootechnical standards.

REFERENCES

Bieda W., Herbut E. 2007. Effect of change in housing system on the productivity of Polish Red cattle using the example of the Cistercian Monastic Farm in Szczyrzyc. Ann. Anim. Sci. 7(2), 295–303.

Bombik T., Biesiada-Drzazga B., Bombik E., Frankowska A. 2011. The influence of temperature and humidity conditions on productivity and welfare of broiler chickens. Acta Sci. Pol. Zoot. 10(4), 23–30.

Bombik T., Kolbuszewski T. 1995. Bilans cieplny nieogrzewanych budynków inwentarskich. Siedlce, Wydaw. WSRP. [in Polish]

Fiedorowicz G., Mazur K. 2011. Mikroklimat pomieszczeń w oborach wolnostanowiskowych w okresie wiosenno-letnim [The microclimate of premises in loose housing in the spring and summer]. Probl. Inż. Rol. 1, 123–134. [in Polish]

Iwańczuk-Czernik K. 1997. Badania zoohigieniczne nad wybranymi elementami środowiska hodowlanego w oborach dla krów mlecznych [Research zoohygienic over selected elements the culture medium in barns for dairy cows]. Acta Acad. Agric. Tech. Olst. Zoot. 45, Suppl. B, 1–60. [in Polish]

Janowski T. M. 1979. Metodyka badań zoohigienicznych. Kraków, Wydaw. PWN.

Kaczor A. 2005. Dobrostan zwierząt w stosowanych systemach i technologiach utrzymania. Dobrostan zwierząt – bydło. Koszalin, EKSPERT-SITR. [in Polish]

Kamieniecki K., Gnyp J., Podolak G. 1998. Zawartość podstawowych wskaźników w mleku w zależności od czynników hodowlanych i środowiskowych [The content of the basic indicators of milk depending on breeding and environmental factors]. Ann. UMCS, Ser. EE 17(6), 43–48. [in Polish]

Kołacz R., Dobrzański Z. 2006. Higiena i dobrostan zwierząt gospodarskich. Wrocław, Wydaw. AR. [in Polish]

Kołacz R., Bodak E. 1999. Dobrostan zwierząt i kryteria jego oceny [Animal welfare and the criteria for its assessment]. Med. Weter. 55(3), 147–154. [in Polish]

Kośla T. 2011. Metodyka badań z higieny zwierząt i prewencji weterynaryjnej. Warszawa, Wydaw. SGGW. [in Polish]

Kupczyński R., Chudoba-Drozdowska B. 2000. Mikroklimat pomieszczeń a zdrowotność i produkcyjność bydła [The microclimate of the premises and the health and productivity of cattle]. Hod. Bydła Trzody Chlew. 9, 12–14. [in Polish]

Neja W., Bogucki M. 2007. Komfort krów a produkcyjność [Cow comfort and productivity]. Hod. Bydła 6/7, 10–17. [in Polish]

Rabek A., Pasierbowski Z., Reklewski Z. 1984. Zootechnika. Warszawa, PWRiL, 150–155. [in Polish]

Rokicki E., Kolbuszewski T. 1999. Higiena zwierząt. Warszawa, Wydaw. Fundacja Rozwój SGGW. [in Polish]

Szulc R., Rzeźnik W. 2007. Mikroklimat: temperatura, wilgotność i ruch powietrza [Microclimate: temperature, humidity and air movement]. Hod. Bydła 10, 26–29. [in Polish]

Trętowski J., Wójcik A.R. 1991. Metodyka doświadczeń rolniczych. Siedlce, Wydaw. WSRP. [in Polish]

Wyszyński Z. 2002. Dobrostan zwierząt gospodarskich. Warszawa, Wydaw. Maz. ODR. [in Polish]

Abstract. The study was aimed at comparing selected physical microclimate parameters in cowsheds with different keeping systems. The experimental material was constituted by four cowsheds (A, B, C and D) located in the Masovian Voivodeship. Cowsheds A and B contained similar numbers of cows (A – 24 heads, B – 26 heads). The cows in these sheds were kept using the stanchion system. Cowsheds C and D contained the following different numbers of cows: 100 and 60 heads. The cows in these sheds were kept in a loose barn system. The study involved zoohygienic inspection of the sheds and an assessment of the selected physical parameters of the microclimate in the winter and spring periods. The cubature of the rooms calculated per one cow in sheds A and B slightly diverged from the recommended zootechnical standards, whereas in sheds C and D, the relevant indices were exceeded more than 5 times. More advantageous microclimatic conditions were found in the stanchion barns. However, as regards cow welfare, loose barns are a better solution. Too low minimal air temperature values were recorded in the loose barns in the winter period in relation to the zoohygienic standards. Relative air humidity in the winter period was similar in all the analysed cowsheds (ranging from 70.0% to 88.8%). In winter, air movement speeds in sheds B, C and D were within the recommended standard range, whereas in cowshed A, the parameter was found to be in excess of the maximal acceptable values. The minimal winter and spring cooling conditions in shed A diverged from the recommended optimum for milk cows. The natural lighting index (O : P) ranged from 1 : 7 in cowshed D to 1 : 107 in cowshed B. In shed B, the index value was too low, due to the building having too few windows. The natural and artificial lighting intensities in the analysed buildings complied with zootechnical standards.