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EVALUATION OF SELECTED PARAMETERS OF HORSE STABLING ENVIRONMENT IN BOX-STALL STABLES

Elżbieta Bombik, Teresa Bombik, Aneta Frankowska

Siedlce University of Natural Sciences and Humanities, Siedlce, Poland

Abstract. The aim of this study was to assess the management conditions of horses at three box stables located in north eastern Mazovia. Range of studies included a zoohygienic inventory of stables and physical parameters measurements of air in the spring period. Scientific research showed that the analyzed elements of horses breeding environment in the box stables were within the recommended standards. On the basis of the stable inventory it was shown that the pits area and cubature idexes were adequate to the zoohygienic requirements. Values of most physical parameters of air (temperature, relative humidity, air movement and cooling power) ranged at the level of the minimum management conditions of horses. Only natural lighting (object B and C) and artificial lighting (object A, B and C) were too low in relation to optimum zoohygienic standards. In the evaluated stables, received light intensity value was twice higher than the recommended requirements (in the course of study outside of analyzed buildings sunny weather prevailed).

Keywords: box stable horse, cubature index, horse, physical parameters of air

INTRODUCTION

The breeder should take utmost care to provide animal welfare, which is a key factor of health, fitness, and performance of the horses [Kolbuszewski and Bombik 1989, Herbut and Walczak 2004]. Microclimate plays an important role in maintaining high standards of animal welfare [Kołacz and Bodak 1999, Jezierski and Jaworski 2006, Kołacz and Dobrzanski 2006]. The stable microclimate parameters include temperature, humidity, air flow and cooling. An important parameter of air that underlies the development, sexual function, and psychological condition of the horses, is the photoclimate [Betlejewska-Kadela 1990]. Horses consume about 75% of the energy metabolism to improve blood circulation in order to produce heat, while the remaining 25% is spent on the motion. Despite the high temperature tolerance, in extreme thermal conditions, horses can lose too much heat, or have difficulty in return heat excess. Defectively constructed stables, improper density (too many animals), defectively functioning ventilation – all these can lead to humidity levels exceeding allowable limits [Houpt and Houpt 1988, Cymbaluk 1994, Curtis et al. 1996, Schatzmann 1998].

Corresponding author – Adres do korespondencji: dr hab. Teresa Bombik prof. nadzw., Department of Animal Reproduction and Hygiene, Siedlce University of Natural Sciences and Humanities, Bolesława Prusa 14, 08-110 Siedlce, Poland, e-mail: ebombik@op.pl

Maintaining microclimatic indices at an optimum level is one of the major issues in the husbandry of horses. Inappropriate living conditions of horses may lead to a decreased immunity and can cause diseases of environmental etiology [Morgan 1998, Max 2003]. The conditions the owners of a farm must fulfill in order to receive direct payments, according to the rules of the Common Agricultural Policy of the European Union since 2013, assure that the farm must comply with the requirements of animal welfare within the cross-compliance.

According to the Regulation of the Minister of Agriculture and Rural Development [Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 2 września 2003, No. 167, item. 1629 No. 167, item. 1629 and No. 116, item. 778], the horses should be kept on bedding: in individual box stalls, standing tie stalls, or a free-stall system. Box stalls are designed to house single horses and to provide freedom of movement, and allow the staff to easily access the animal. The elimination of close contact with other horses in the individual box-stall stables limits the risk of many diseases [Waran 2002]. So far, studies conducted show that most of the evaluated parameters of the environment in the stables deviate from optimal hygienic standards [Kolbuszewski et al. 1995, Pietrzak and Tietze 1999, Kupczyński and Mazurkiewicz 2004, Bombik et al. 2009].

The aim of this study was to evaluate the welfare of horses housed in box-stall stables.

MATERIAL AND METHODS

The experimental material consisted of three box-stall stables located in north-eastern Mazovia, Poland. The number of horses kept in the studied stables (A, B and C) was varied and was, respectively, 10, 16 and 5 individuals.

The welfare assessment of horses in the stables were made according to the animal hygiene inventory and by direct measurement of microclimate according to the methodology by Kośla [2011]. The inventory of stable buildings and boxes included measuring their sizes, determining the number and size of windows, as well as the number and power of light bulbs. Based on the above data, we calculated surface-cubature ratios, natural light accsess (the ratio of glazed area of windows to the floor area, W : F) and artificial lighting power (in $W \cdot m^{-2}$).

Measurements of physical parameters of microclimate inside and outside of the stables were carried out in spring. Temperature and relative air humidity was measured using the COMET D3121 thermo-hygrometer, air flow speed with anemometer AIRFLOW TA35, cooling power by Hill's katathermometer, and illumination with a light meter HD 9221. Measurements were performed twice daily (at 10.00 and 17.00 hrs) at the withers hight of the horse in three places in the stables. The first point was located in the central zone of the room, while the second and the third were in the peripheral parts of the stable. When making internal measurements, corresponding physical parameters were simultaneously measured outside the stables.

The data resulting from the microclimate survey inside and outside the stables were procvessed statistically [Trętowski and Wójcik 1991], describing all measured air parameters with arithmetical mean ($\overline{x}$) and coefficient of variation (V%). The descriptive statis-

tics also include the minimum and the maximum values of temperature, relative air humidity, air flow velocity, cooling power of the environment, and lightning intensity.

The collected data allowed evaluation of the welfare environment of the horses maintained in the studied stables.

RESULTS AND DISCUSSION

The main purpose of a stable is to protect the horses against adverse weather conditions and provide them with optimal living environment [Kołacz and Bodak 1999, Fiedorowicz et al. 2004 a].

The data presented in Table 1 show that the surface area an individual box stall ranged from 10.8 m^2, in stable C, to 24.0 m^2, in a stable B, and corresponded to the recommendations of animal hygiene. According to the Regulation of the Minister of Agriculture and Rural Development [Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 2 września 2003, No. 167, item. 1629, with further amendments] a box stall minimum area should be at least 9 m^2 for an adult horse with a height at withers above 1.47 m. Kaletowski [1997] recommends a larger box stall for recreational horses, of about 10.5 m^2, and according to Fiedorowicz et al. [2004 a, b], a box stall optimal size should be 12 m^2. The cubature index ranged from 32.4 m^3 (in stable C) to 76.8 m^3 (in stable B). In all the surveyed stables, this index was higher than that recommended by Fiedorowicz et al. [2004 a, b], i.e. 30 m^3 for horses. According to Kośla [2011], the cubature index should range from 24 to 45 m^3 per horse. Given the above standards, it should be noted that in the stables of A and C, this index ranged within the recommended limits.

Table 1. Area-cubature indexes of analyzed stables
Tabela 1. Wskaźniki powierzchniowo-kubaturowe badanych stajni

Specification – Wyszczególnienie	Stable – Stajnia		
	A	B	C
Building measurements, m – Wymiary budynku, m			
length – długość	16.5	32.0	7.5
width – szerokość	8.5	12.0	7.2
height – wysokość	3.1	3.2	3.0
Number of box stalls – Liczba boksów	4	16	6
Indexes – Wskaźniki			
area, $m^2 \cdot head^{-1}$ – powierzchniowe, $m^2 \cdot osob.^{-1}$	14.0	24.0	10.8
cubature, $m^3 \cdot head^{-1}$ – kubaturowe, $m^3 \cdot osob.^{-1}$	43.5	76.8	32.4

The data presented in Table 2 show that the air temperature inside the studied stables in the spring ranged within the optimum, which for horses should be from 5 to 28°C [Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 2 września 2003, Rajchert 2009]. The lowest average temperature was recorded in stable A, while the highest in the object C (respectively: 10.1 and 13.3°C). The highest air temperature variation was found in stable A, were the coefficient of variation was 15.2%. In the analyzed period, the air temperature outside stables A and C were less diverse and ranged, respectively, 7.4–9.1°C and 11.1–

14.4°C. The highest differences in air temperature have been observed outside of the stable B (V = 23%).

In the objects A and B, the upper range of humidity levels exceeded the acceptable standards. Under the Regulation [Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 2 września 2003] in the field of animal welfare, the relative humidity in the room for horses should not exceed 80%. The lowest relative humidity of air was recorded in stable C (50.7–66.0%). Such low relative humidity inside the facility could have resulted from higher air temperature and lower humidity outside (51.0–83.1%), compared to other stables. The highest ambient relative humidity variability was measured outside stable C (V=21.3%). Average relative humidity levels outside stables A and B were at a similar level, exceeding the value of 80.0%.

Table 2. The values of the temperature (°C) and air relative humidity (%) in stables and outside

Tabela 2. Wartości temperatury (°C) i wilgotności względnej powietrza (%) w stajniach i na zewnątrz

Parameters Parametry	Measurement places Miejsca pomiarowe	Statistics measure – Miary statystyczne		
		range – zakres	$\overline{x}$	V%
Air temprature Temperatur powietrza	A	8.5–12.5	10.1	15.2
	B	11.4–14.3	12.9	10.8
	C	11.8–14.4	13.3	9.0
	outside – na zewnątrz			
	A	7.4–9.1	8.2	8.5
	B	9.6–14.8	12.1	23.0
	C	11.1–14.0	12.8	10.2
Relative humidity Wilgotność względna	A	74.7–83.0	77.8	3.9
	B	74.0–81.5	78.0	3.7
	C	50.7–66.0	57.1	11.5
	outside – na zewnątrz			
	A	84.2–89.1	86.8	2.0
	B	76.3–86.3	82.4	4.7
	C	51.0–83.1	70.3	21.3

The thermal and humidity conditions are an important part in the husbandry of horses and have been studied by many authors [McBride et al. 1983, Curtis et al. 1996, Kołacz and Bodak 1999, Budzińska-Wrzesień and Wrzesień 2005, Łojek et al. 2005, Fiedorowicz 2007 a, b, Fiedorowicz and Łochowski 2008, Bombik et al. 2009, Sowińska et al. 2010]. In the studies by Budzińska-Wrzesień and Wrzesień [2005], the range of fluctuations in the evaluated parameters in the stablec for temperature was 16.0–21.3°C and for relative humidity 49.7–80.0%. Sowińska et al. [2010] reported temperatures and humidity values in a box-stall stable ranging, respectively, 7.8–15.9°C and 70.5%, while in a standing-stall stable 5.6–14.0°C and 81.0%.

According to the data in Table 3, the average value of air flow in the box-stall stables was very low and ranged from 0.02 m · s^{-1} (in stables B and C) to 0.05 m · s^{-1} (in stable A). The coefficient of variation calculated for the velocity of air in the studied stables remained

within the range from 12.0 to 100.0%, which may indicate that the windows and/or doors were opened or draughty. Range of air velocity in the studied facilities did not exceed the level of 0.3 m · s^{-1}, which is considered the maximum value in facilities for horses [Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 2 września 2003, Bek-Kaczkowska 2005]. A similar range of air flow velocity in horse-housing facilities was published by Budzińska-Wrzesień and Wrzesień [2005]. Significantly higher values of this parameter, at the level of 0.15–0.35 m · s^{-1}, were reported by Łojek et al. [2005]. The average value of air velocity outside the studied stables was higher and ranged from 0.49 to 0.60 m · s^{-1}. The presented study revealed no effect of the external climate on air flow speed inside the buildings.

Table 3. The values of the air movement (m · s^{-1}) and cooling power (mW · cm^{-2}) in stables and outside

Tabela 3. Wartości ruchu powietrza (m · s^{-1}) i ochładzania (mW · cm^{-2}) w stajniach i na zewnątrz

Parameters Parametry	Measurement places Miejsca pomiarowe	Statistics measure – Miary statystyczne		
		range – zakres	$\bar{x}$	V%
Air movement Ruch powietrza	A	0.04–0.06	0.05	12.0
	B	0.00–0.04	0.02	100.0
	C	0.00–0.03	0.02	100.0
	outside – na zewnątrz			
	A	0.17–0.86	0.49	51.0
	B	0.28–1.10	0.50	62.0
	C	0.17–1.44	0.60	76.7
Cooling power Ochładzanie	A	16.7–38.3	28.3	11.9
	B	26.2–77.0	48.7	5.2
	C	25.2–63.0	44.8	7.5
	outside – na zewnątrz			
	A	9.5–25.3	16.7	31.1
	B	13.0–40.0	24.8	29.3
	C	17.3–50.8	32.4	7.7

Mean values of cooling in stables B and C were similar, 48.7 and 44.8 mW · cm^{-2}, respectively. A lower average value of this parameter was found in stable A (28.3 mW · cm^{-2}). Optimum cooling standards for horses should fall within the limits of 29–45 mW · cm^{-2} [Fiedorowicz and Łochowski 2008]. Considering the above reference range, it must be noted that in both stables, B and C, where we recorded the cooling power of, respectively, 77.0 and 63.0 mW · cm^{-2}, the upper limit of the acceptable range was exceeded. The research by Kupczyński and Mazurkiewicz [2004] have shown similar values of cooling in stables (44.7–51.1 mW · cm^{-2}). Slightly lower average cooling results for a box-stall stable (36.4 mW · cm^{-2}) were reported by Bombik et al. [2009]. Kolbuszewski et al. [1995], on the other hand, found very high values of cooling (43.5–149.7 mW · cm^{-2}) in dam and sport stables, caused by adverse thermal humidity patterns and drafts. The variability of "dry" cooling in the analyzed facilities was low (V = 5.2 to 11.9%).

Analyzing the photoclimate of the stables, one should conclude that natural illumination was provided by windows of standard sizes. The data presented in Table 4 show that the ratio of window glazed area to floor area (W : F) in the evaluated sites ranged from 1 : 14, in stable A, to 1 : 2,3 in stable C. According to many authors, the recommended value of the natural light index (W : F) in the premises for horses should not be greater than 1 : 15 [Kaletkowski 1997, Fiedorowicz 2007 a, b, Jodkowska 2007]. Stables B and C did not meet the requirements in this regard. Stable buildings are required to provide daylight at the level which facilitates proper growth and development, as well as good physical and mental health of the horses. Studies by other authors also indicate that the stables do not always provide an adequate access to daylight. Budzińska-Wrzesień and Wrzesień [2005] reported the W : F ratio in stables at the level 1 : 25 and 1 : 32. More unfavorable W : F ratios in facilities for horses were deomonstrated by Łojek et al. [2005], which was 1:47. Pietrzak and Tietze [1999] demonstrated that daylight intensity in two stables was too low (W : F = 1 : 20 and 1 : 30).

Table 4. The characteristic of natural and artificial lighting in the stables
Tabela 4. Charakterystyka oświetlenia naturalnego i sztucznego w stajniach

Specification – Wyszczególnienie	Stable – Stajnia		
	A	B	C
Number of windows – Liczba okien	12	17	2
Windows measurements – Wymiary okien			
width, m – szerokość, m	1.12	1.20	1.70
height, m – wysokość, m	0.75	1.00	0.70
Natural lighting (W : A) – Oświetlenie naturalne (W : F)	1:14	1:19	1:23
Artificial lighting, $W \cdot m^{-2}$ – Oświetlenie sztuczne, $W \cdot m^{-2}$	2.5	5.0	5.5
Lighting intensity, lx – Natężenie oświetlenia, lx	50.0	52.5	59.4

An important parameter for indirect evaluation of artificial lighting in the building is a conversion of the number of bulbs and their power per 1 m^2 of stable. The facilities studied revealed this ratio ranging from 2.5 $W \cdot m^{-2}$, in stable, A to 5.5 $W \cdot m^{-2}$, in stable C. According to Kośla [2011], the optimal power of artificial lighting in a premises for horses should range from 8 to 16 $W \cdot m^{-2}$ (respectively, for working horses and for mares with foals).

According to Kośla [2011], illumination in facilities for horses should be in the range of 15–30 lx. In the present study, this parameter was almost 2-fold higher and ranged from 50.0 lx (in stable A) to 59.4 lx (in stable C). In studies by Kupczyński and Mazurkiewicz [2004], carried out in horse stables in the region of Warmia and Masuria, the average illuminance was found within the limits of the optimum range.

CONCLUSIONS

Over the recent years, a considerable improvement in welfare of horses has been observed. The study shows that the analyzed components of the environment of horses housed in box-stall stables ranged within the limits of recommended standards. Based on the stable inventory, it has been confirmed that the surface area and cubature indicators of

box stall met the requirements of animal hygiene. Most physical air parameters (temperature, relative humidity, air velocity and cooling power), remained at the minimum level of welfare of horses housing. Only natural light (at facilities B and C) and artificial light (at facilities A, B and C) were too low in relation to optimum hygienic standards. Light intensity in the studied stables was 2-fold higher than the recommended requirements (the weather outside the building during measurements was sunny).

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ANALIZA WYBRANYCH ELEMENTÓW ŚRODOWISKA HODOWLANEGO KONI W STAJNIACH BOKSOWYCH

Streszczenie. Celem pracy była ocena warunków utrzymania koni w trzech stajniach boksowych, zlokalizowanych na terenie północno-wschodniego Mazowsza. Zakres badań obejmował inwentaryzację zoohigieniczną stajni i pomiary parametrów fizycznych powietrza w okresie wiosennym. Z przeprowadzonych badań wynika, że analizowane elementy środowiska hodowlanego koni w stajniach boksowych kształtowały się w granicach zalecanych norm. Na podstawie inwentaryzacji stajni wykazano, że powierzchnia boksu i wskaźniki kubaturowe odpowiadały wymaganiom zoohigienicznym. Powierzchnia boksu, przypadająca na jednego konia, wynosiła od 10,8 m^2 w stajni C do 24,0 m^2 w stajni B. Wskaźnik kubaturowy przyjmował wartości od 32,4 m^3 (w stajni C) do 76,8 m^3 (w stajni B). Wartości większości parametrów fizycznych powietrza: temperatury (średnia 10,1 do 13,3ºC), wilgotności względnej (średnia 57,1 do 78,0%), prędkości ruchu powietrza (średnia 0,02 do 0,05 $m \cdot s^{-1}$) i ochładzania (średnia 28,3 do 48,7 $mW \cdot cm^{-2}$) mieściły się na poziomie minimalnych warunków utrzymania koni. Jedynie oświetlenie naturalne (w obiekcie B i C) i sztuczne (w obiekcie A, B i C) było za niskie w stosunku do optymalnych norm zoohigienicznych. W badanych obiektach wskaźnik liczby żarówek i ich mocy na 1 m^2 powierzchni użytkowej stajni wynosił od 2,5 $W \cdot m^{-2}$ w stajni A do 5,5 $W \cdot m^{-2}$ w stajni C. W ocenianych stajniach natężenie oświetlenia przyjmowało wartość 2-krotnie wyższą od zalecanych wymagań i wynosiło od 50,0 lx (w stajni A) do 59,4 lx (w stajni C) (w trakcie badań na zewnątrz obiektów panowała słoneczna pogoda).

Słowa kluczowe: koń, parametry fizyczne powietrza, stajnia boksowa, wskaźnik kubaturowy

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