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THE COMPARISON OF HORSES MANAGEMENT CONDITIONS IN THE BOX STALL STABLE AND THE HORSE-BARN

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K e y w o r d s: box stall stable, horse-barn, microclimate, welfare.

A b s t r a c t

The aim of this study was to compare the breeding environmental conditions in the box stall stable and the horse-barn. Assessment of the breeding environment was performed on the basis of the stable area and the cubic capacity as well as on microclimate measurements over the autumn and winter period. The results of the study indicate that both the box stall stable and the horse-barn provided a proper areal and cubic conditions, but the microclimate conditions were better in the stall box stable. In the horse-barn most of microclimate parameters (air temperature, relative humidity, air movement, cooling power and natural illumination conditions) exceeded the allowable level in larger degree than in the box stall stable. The dust pollution level in both stables, did not exceeded the allowable level and its size dependent on work conducted in the stables.

PORÓWNANIE WARUNKÓW UTRZYMANIA KONI W STAJNI BOKSOWEJ I BIEGALNI

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S ł o w a k l u c z o w e: stajnia boksowa, biegalnia, mikroklimat, dobrostan.

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Abstrakt

Celem pracy była ocena i porównanie warunków utrzymania koni w stajni boksowej i biegalni. Ocenę wykonano na podstawie wskaźników powierzchniowo-kubaturowych oraz wyników pomiaru mikroklimatu w okresie jesienno-zimowym. W badaniach wykazano, że oba obiekty zapewniały prawidłowe wskaźniki powierzchniowo-kubaturowe, natomiast w stajni boksowej panowały korzystniejsze warunki mikroklimatyczne. W biegalni większość parametrów mikroklimatycznych (temperatura powietrza, wilgotność względna, prędkość ruchu powietrza, ochładzanie i fotoklimat) w większym stopniu niż w stajni boksowej odbiegało od zalecanych norm zoohigienicznych. Poziom zapylenia powietrza w obu obiektach nie przekraczał wartości dopuszczalnych, a jego wielkość zależała od rodzaju wykonywanych prac w obiektach.

Introduction

In Poland, horses in mass breeding system are kept in three types of stables: tether stalls stables, box stall stables and horse-barns. Boxes and horse-barns are much more comfortable for horses than tether stalls. Boxes allow each animal to have its own space and personal management routine according to the wishes of individual owners (WARAN 2002). In the horse-barn horses are group housed, which gives them opportunity to both: free movement and social interactions between members of a team. It is cost effective and also relatively low maintenance. The main concern with the system relates to the risk of injury resulting from aggression between animals, and also the fact that some aspects of horses' health are more closely dependent upon that of other members of the group (WARAN 2002). But regardless of type of a stable, their main role is to provide favourable environmental conditions, which are one of the most important elements guaranteeing animals; proper health, condition, and productivity, that is – a very good welfare. Microclimate conditions play an important role, in assuring the good welfare (JEZIERSKI, JAWORSKI 2006). The basic values of the quality of stable microclimate are: natural illumination conditions, thermal-humidity conditions and the level of air cleanliness. The illumination is the element, which influences the development, psyche and reproduction functions of animals (BETLEJEWSKA-KADELA 1990). Air temperature, relative humidity, air movement, cooling power are not less important, and they should be correlated in such a way to create the best as possible thermal-humidity conditions (PRUCHNIEWICZ 2003). The resultant of air temperature, humidity, air movement, solar radiation intensity and temperature of inside construction surfaces is the cooling rate, which is used to the complex evaluation of the climate factors impact on living organisms (KOŚLA 2001). The optimal microclimate of buildings, where animals are kept, is the basic condition to raise healthy herds of animals. However, the maintenance of microclimate parameters in stables is one of main problems in horse husbandry. The conditions in which horses are kept are also important due to the Common Agricultural Policy (CAP) reforms in EU countries, which brings changes principles in receiving direct supplement by farm owners. Since 2013 the condition to obtain such supplement is going to be the fulfillment of cross-compliance stipulation involving the animal welfare obligation. Due to this fact, the owners of the stables are going to be interested in such breeding systems, that will be the easiest to provide the best welfare conditions to their horses.

The aim of this study was to compare the breeding environmental conditions in the box stall stable and horse-barn.

Material and Methods

The study was carried out over a period of four months in autumn and winter (November- February) in the box stall stable and the horse-barn. They were located in the north-eastern region of Poland. Both buildings differed in general area, surface area per one horse, cubic capacity and existence of windows in the building. Basic areal and cubic conditions indexes are shown in Table 1.

Table 1

Area-cubature indices of stable buildings

Specification	Box stall stable	Horse-barn
Number of housed horses	17	16
General area [m^2]	452.2	229.6
Box area surface/ area surface per one horse [m^2]	10.5	14.3
Cubature of the building [m^3]	994.8	1115.8
Cubic capacity per one horse [m^3]	58.5	69.7

Box stall stable was a building from the 18th century, completely renovated in 1996. The long axis run in the north-south direction. The length of the building was 32.3 m, width 14.0 m, height 2.2 m. Cubature of the building came to 994.8 m^3, whereas cubic capacity 58.5 m^3. The building had a total usable area of 452.2 m^2. Seventeen box stalls, for seventeen recreational horses, with a surface area of 10.5 m^2 (3.5×3.0 m) formed two rows separated by a corridor. In both gable walls were entrance gates divided into four sections that opened individually to the outside. In side walls there were ten windows measuring 1.75×0.73 m and five windows measuring 1.2×0.9 m. The loft of the stall box stable was the place, where the straw and hay was kept.

Horse-barn was a building converted from a shed. There were 16 weanling horses kept in the horse-barn stable. The long axis run in the north-south direction. The length of the building was 20.50 m, width 11.20 m, height 4.86 m. Cubature of the building came to 1115.8 m^3, whereas cubic capacity to 69.7 m^3. The building had a total usable area of 229.6 m^2 while surface area per one horse came to 14.3 m^2/horse. The entrance gate was localized in the long wall of a building and it was divided into four sections that opened individually. There were no windows in the horse-barn stable, and the only source of daylight was the opened entrance gate. The loft was a place where hay and straw was kept.

In both stables there was a lack of planed ventilation system, and the air change was carried out by opening entrance gate (horse-barn) and entrance gate and windows (box stall stable).

Temperature and relative air humidity were measured regularly throughout the period of the study. The following momentary measurements were performed: air flow rate, cooling rate, dust pollution of air. Regular temperature and humidity measurements were carried out using LB-520 digital thermohygrometers (LAB-EL) which registered the above parameters at two-hour intervals. Thermohygrometers were placed outside and inside the box stall stable and the horse-barn at permanent monitoring points (6 points in the stall box stable and 4 points in the horse-barn stable). Thermohygrometer data were used to calculate average daily temperatures and relative humidity. Extreme values were recorded. Momentary measurements of microclimatic conditions (air flow and cooling rate) were performed at permanent monitoring once a week, three times a day at 6.00–7.00, 12.00–13.00 and 17.00–20.00 using Hill's katathermometer. Dust pollution was measured once a fortnight, three times a day- during the work conducted in the buildings in the morning and in the evening, and during the quiet time. Dust pollution was determined with the use of Zeiss conimeter. Samples were gathered from every box stall from the level of horses' heads. The classification of air dustiness in the investigated stable was determined on the basis of number of particles in 1 cm^3 of air. The intensity of the dust pollution was defined as follows: medium – number of particulates to 100–200 particles/cm^3, significant – number of particulates 200–300 particles /cm^3, intense – number of particulates to 300–400, particles /cm^3, very intense – number of particulates > 400 particles/cm^3 (GRZEGORZAK et al. 1983).

The stables' natural illumination conditions were based on the W:F ratio (ratio of glazed window area to floor area), and the daylight coefficient (DC) was computed based on luxometric readouts. Daylight was measured using the L-51 luxometer (SONOPAN). All measurement and calculations were performed with methods commonly used in zoohygiene investigations (KOŚLA 2001).

The values of the investigated traits ($\bar{x}$ ±SD, min-max) were processed statistically using Statistica 8.0 PL software. The significance of differences between mean values in experimental groups was determined by a one factor analysis of variance in an orthogonal design and the new multiple range test.

Results and Discussion

From the data shown in Table 1, arises that both the surface area of the box and the surface area per one horse in the horse-barn fulfilled the recommendations. According to Ministry of Agriculture and Rural Development Regulation (Rozporządzenie... Dz.U. z 2010 r., nr 116, poz. 778) the minimal surface area of the box should not be less than 9 m^2. WARAN (2002) recommends different dimension of boxes according to the size of a horse. For ponies advised dimension is 9 m^2 whereas for large breeds not less than 13 m^2. The box stall area of investigated stable measured 10.5 m^2, thus it fulfilled the norm contained in the Regulation. However as it comes to loose system barns, including horse-barns the recommended surface per one adult horse should be 10 m^2 (WARAN 2002, Rozporządzenie... Dz.U. z 2010 r., nr 116, poz. 778). The area surface per one horse in the investigated horse-barn amount to 14.3 m^2, therefore it was in compliance with recommendations and the Regulation.

The important element having an influence on the stable's microclimate is the cubic capacity of a building, that is a volume of air per one horse. In both investigated buildings values of cubic capacity were higher than 24–45 m^2 (KOŚLA 2001) and 30 m^2 recommended by FIEDOROWICZ et al. (2004).

From the data presented in Table 2 it arises that the average temperature in the horse-barn for the whole period of study was significantly lower ($P \leq 0.05$) than in the box stall stable (appropriately 3.6 and 7.5^{o}C). During the study period extreme temperature values were also lower in the horse-barn than in the box stall stable (appropriately -7.1 and -0.9^{o}C). Other authors revealed in the winter period also variable temperatures which values oscillated as follows: -0.3 to 10.3^{o}C in the box stall stable (SOWIŃSKA et al. 2010), 7.8–15.9^{o}C in the box and 5.6–14.0^{o}C in the standing stall (BOMBIK et al. 2009) and 3.4–5.7^{o}C (ŁOJEK et al. 2005).

The level of relative humidity during the whole period of study was on similar level in both buildings (box stall stable 91.8%, horse-barn 94.0%). It is necessary to mention that in both stables oscillation range as well as the highest extreme values were approximate, which indicates the full atmospheric water vapor content. Other authors' results show also variable values of the relative humidity of air in stables. Generally, compared to results presented in Table 2 the values were lower and they occurred in extent as follows: 49.7–80%

Table 2

Microclimatic conditions in stable buildings (± SD, min-max)

Parameter		Stall box stable	Horse-barn
Air temperature [°C]	$\bar{x}$	7.5^b	3.6^a
	SD	4.80	6.03
	range	-0.9–15.5	- 7.1–13.4
Relative air humidity [%]	$\bar{x}$	91.8	94.0
	SD	9.30	8.55
	range	70.6–100.0	71.00–100.0
Air flow rate [m s^{-1}]	$\bar{x}$	0.23^a	0.37^b
	SD	0.13	0.12
	Range	0.04–0.50	0.11–0.70
Katathermometic estimation of cooling [mW cm^2]	$\bar{x}$	43.4^A	53.9^B
	SD	4.24	9.99
	range	37.39–49.45	37.47–67.12

Explanation: *A, B* – $P \leq 0.01$; *a,b* – $P \leq 0.05$

(BUDZIŃSKA-WRZESIEŃ, WRZESIEŃ 2005), 52.3–99.0% (FIEDOROWICZ, ŁOCHOWSKI 2008), 67.0–86.0% (in the box) (HOUBEN 2008).

Average values of air flow rate for the whole study period was significantly lower ($P \leq 0.05$) in the box stall stable than in the horse-barn and it reached the following values: 0.23 and 0.37 m s^{-1}. While the oscillation range of this parameter for the whole period of study was to total: 0.04–0.50 and 0.11––0.76 m s^{-1}. Other authors' results imply the fluctuation of the parameter. Obtained results were: 0.02–1.89 m s^{-1} (SOWIŃSKA et al. 2010), 0.2–0.6 m s^{-1} (in the box) (HOUBEN 2008) and 0.15–0.35 m s^{-1} (ŁOJEK et al. 2005).

As crucial determinants of the horse welfare, temperature, humidity conditions and air flow rate in stables have been investigated by numerous authors (BOMBIK et al. 2009, BUDZIŃSKA-WRZESIEŃ, WRZESIEŃ 2005, CURTIS et al. 1996, FIEDOROWICZ, ŁOCHOWSKI 2008, HOUBEN 2008, ŁOJEK et al. 2005, SOWIŃSKA et al. 2010). It is specified that the temperature inside of a stable should not be lower than 5°C (Rozporządzenie... Dz.U. z 2010 r., nr 116, poz. 778, RAJCHERT 2009), the relative humidity should not exceed the level of 80% (Rozporządzenie... Dz.U. z 2010 r., nr 116, poz. 778, FIEDOROWICZ, ŁOCHOWSKI 2008), and the air flow rate 0.3 m s^{-1} (BEK-KACZKOWSKA 2005, PIETRZAK, TIETZE 1999, KOLBUSZEWSKI et al. 1995). On the contrary according to PRUCHNIEWICZ (2003) the highest temperature during winter should not be higher than 8°C.

To relate the above results to the own study results, it ought to be stated, that the average temperature in the horse-barn was lower than 5°C, while relative humidity exceeded allowable level of 80% with the air flow rate indicating occurrence of draughts. Whereas in the box stall stable, although the equally high air humidity, the temperature was higher and the air flow rate was lower. It can be said that the thermal conditions in the box stall stable were more favourable than in the horse-barn. The results of cooling rate, which are the resultant of concurrence of temperature, humidity and air flow rate values seem to confirm the above statement. Average values of cooling rate for whole study period were higher ($P \leq 0.01$) in the horse-barn (53.9 mW cm^{-2}) than in the box stall stable (43.4 mW cm^{-2}). Referring the above data to the recommended values of cooling rate (29–45 mW cm^{-2}) (FIEDOROWICZ, ŁOCHOWSKI 2008) it needs to be said that, the top level of that scope was exceeded in the horse-barn. The maximum values of cooling rate for whole period of study surpassed the top allowable level in both buildings, but to a greater degree in the horse-barn (67.1 mW cm^{-2}) than in the box stall stable (49.5 mW cm^{-2}).

Cooling rate is believed to be a good indicator of the animals' subjective perception of cold, heat and thermal comfort, the problem of cooling in horse stables during winter was investigated by other authors (SOWIŃSKA et al. 2010, BOMBIK et al. 2009, FIEDOROWICZ, ŁOCHOWSKI 2008). FIEDOROWICZ and ŁOCHOWSKI (2008) obtained too low values of cooling rate (11.73 mW cm^{-2} with the stable gate closed and 15.08–18.69 mW cm^{-2} with the stable gate open), which may indicate the probability of overheating the horses' organisms, especially during the night with the gate closed. Proper average values of the cooling rate were gained by BOMBIK et al. (2009), and they amount to: in the box stall stable 36.4 mW cm^{-2} and 41.3 mW cm^{-2} in the tether stall stable. Approximate to the top allowable level cooling rate in two box stall stables were obtained by SOWIŃSKA et al. (2010), the average values during the study period shall amount to 47.15 and 44.82 mW cm^{-2}. However, the authors reveled, that the maximum values of this index in all investigated buildings exceeded significantly allowed values (appropriately: 98.9 mW cm^{-2}; 76.8 mW cm^{-2}).

The required supply of daylight in stables guarantees the proper development and psychological and physical form. The recommended values of window-floor (W:F) ratio should not exceed 1:15 (FIEDOROWICZ 2007, JODKOWSKA 2007). In the own investigation (Table 3) the obtained results of W:F ratio amount to: 1:25 (box stall stable), while in the horse-barn the parameter was immeasurable because of the lack of windows in the building. The daylight illumination factor in the box stall stable (0.03%) and in the horse-barn (0.01%) did not correspond with the minimal recommended value for stables of 0.5% (JODKOWSKA 2007). The other authors investigations results concerning daylight illumination condition, also indicate that not all stables provide horses with adequate exposure to daylight. In the study of two stables BUDZIŃSKA-WRZESIEŃ and WRZESIEŃ (2005) reported W:F ratios of 1:32 and 1:25, even less satisfactory W:F ratio of 1:47 was noted by ŁOJEK et al. (2005). Comparing the results of daylight illumination from own investigation to the recommended values from zoohygiene norms, it needs to be concluded that neither box stall stable, nor horse-barn failed to fulfill the requirements in this extent. The reasons for this fact was insufficient number of windows in the box stall stable and unsuitable cleanliness of glazed windows and walls. Instead in the horse-barn there were no windows, and the only source of daylight was the open gate.

Table 3

Illumination conditions in stables

Specification	Stall box stable		Horse-barn
	number	dimension	
Windows	10 5	1.75 × 0.73 1.20 × 0.90	none
Ratio of window area to floor area [W:F]	1:25		–
Daylight coefficient DC [%]	0.03		0.01

The level of air dustiness is presented in Table 4. The data noted in this study met standards of allowable 400 particle per cm^3 (GRZEGORZAK et al. 1983), but the more fulfilling conditions were noted in the horse-barn stable. It needs to be stated that the dustiness of air depend on both: work conducted in the stable and the housing system – in the box stall or horse-barn.

Table 4

The level of air dustiness (particles/cm^3) with the consideration of work conducted during the day

Measurement number	Activity	Box stall stable	Horse-barn
1	morning work quiet time evening work	238 150 524	205 122 208
2	morning work quiet time evening work	250 102 241	215 109 208
3	morning work quiet time evening work	551 170 262	127 202 111
4	morning work quiet time evening work	270 129 162	132 100 160
5	morning work quiet time evening work	230 113 149	123 101 130
6	morning work quiet time evening work	233 130 110	174 116 123

Concluding the received results it is possible to state that box stall stable provided more beneficial values of factors characterizing the thermal comfort of the environment (temperature, relative humidity, cooling rate, air flow) than the horse-barn. However both buildings failed to provide the proper daylight illumination. On the contrary it needs to be taken under consideration that although the microclimatic conditions were worse in the horse-barn, horses kept in this housing system had the possibility of movement on larger area surface than horses kept in the box stall stable, as well they had freedom of social interactions.

Owing to a long life span and a wide range of uses, horses have special requirements which distinguish them from other domestic animals. Building new stables, and adapting the existing buildings for stables does not always correspond with the expertise knowledge related to the environmental needs of the horse. Stall box area surface, feed mangers and automatic waters properly and functionally placed are mostly the main concern for horse stable owners. While efficient ventilation providing favorable microclimate, and also the appropriate illumination conditions, having important impact on horses; quality of life are often underestimated by both designers and users of the stables.

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