Annals of Warsaw University of Life Sciences – SGGW
Animal Science No 52, 2013: 67–75
(Ann. Warsaw Univ. of Life Sci. – SGGW, Anim. Sci. 52, 2013)

The welfare of horses assessed by the investigations of chosen parameters of the stable microclimate

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Abstract: *The welfare of horses assessed by the investigations of chosen parameters of the stable microclimate.* The performed investigations aimed at assessing the welfare of horses on the basis of the examination of chosen parameters of the stable microclimate. The investigations were carried out at the Wolica horse riding complex of Warsaw University of Life Sciences. The objects of the investigations were two buildings with breeding environments. The investigations were carried out during three seasons: summer, autumn and winter. The investigated basic parameters of the microclimate were: air temperature, relative humidity, air cooling force and movement as well as the type and intensity of lighting. The results were compared with the binding norms. The obtained results show that the parameters agree with the recommendations of animal hygiene exceeding the norms only sporadically. The welfare was maintained.

Key words: welfare of horses, stable, microclimate

INTRODUCTION

Since 1997 The Law on the Protection of Animals (Ustawa 2003) has been in effect in Poland. It regulates the legal situation of animals, point 1 of the Law says that animal as a living creature, capable of suffering is not a thing. The human being should respect, protect and provide care to it as well as humane treatment. Detailed laws, regulating horse breeding can be found in the Regulation of the Minister of Agriculture and Rural Development on the minimum conditions for the maintenance of livestock for which protection norms are not defined in the UE regulations which has been in effect since 30 June 2010 (Rozporządzenie 2010).

The main principle of animal welfare is to ensure that animals are hungry or thirsty, free from pain, traumas and diseases as well as from fear, stress and discomfort and are able to behave in their normal way (Kołacz and Bodak 1999). While assessing the welfare of animals we should remember the inventive act of March 1928, signed by the President of Poland I. Mościcki (Obwieszczenie 1932) concerning the protection of animals and forbidding their ill-treatment.

At present one can observe the division of the welfare indexes into four groups: physiological, behavioural, health and productive (Moberg 1985, Broom and Johnson 1993). There are also some supplementary indicators such as barn parameters including its microclimate (Kołacz and Bodak 1999).

The barn should maintain the optimum microclimate for the animals which ensure their welfare, productivity and effective use. Badly designed or constructed appliances of the building do not allow obtaining satisfactory productive effects, the animals show health problems and their welfare cannot be fully ensured (Lewandowski 1997, Kołacz 2000, Fiedorowicz et al. 2004).

The performed investigations aimed at assessing the welfare of horses on the basis of chosen parameters of the stable microclimate.

MATERIAL AND METHODS

The investigations were carried out at Wolica stables of Warsaw University of Life Sciences from 21 June 2006 to 16 February 2007. The investigated objects were two stables (new and old) built in the same area where the measurements were also taken. The objects comprised physically separate breeding environments. The evaluation concerned the microclimate of the buildings. An attempt at assessing the conformity of zoohygienic parameters with the binding standards (Rozporządzenie 2010). The current order concerning horse management is very general, so other zoohygienic standards accepted for stables were also used (Rozporządzenie 2003, Fiedorowicz et al. 2004, Kołacz and Dobrzański 2006, Kośla 2011).

The examined period was divided into three measuring seasons: summer, autumn and winter. In each season, at a week's interval, measurements were taken for 5 days with three series of measurements every day (at 7 a.m., 1 and 7 p.m.). The measurements were taken in both neighbouring stables and outside between the buildings.

The measurements included the air temperature, relative humidity, temperature of the dew-point, atmospheric pressure, air cooling force and movement. In each season the light intensity was measured in the buildings with natural and artificial lighting and outside for the comparison.

Temperature (°C), relative humidity (%), dew-point (°C) and atmospheric pressure (hPa) were measured with a thermo-higrometer LB-707B with a built-in barometric modulus (produced by LAB--EL). In the stables the panel was installed in the middle of the corridor and the probe was tested at the height of 80 cm from the floor. The measurements of the air cooling force were done with the Hill Katathermometer and the results were also used for calculating the air movement velocity (Kośla 2011). At the same time the air movement velocity was measured with the help of the vane anemometer with digital readout. Illumination (lx) was measured with a light meter. The measurements were taken inside the new and old stable with attention paid to the reading place, i.e. the middle of the corridor, in a sunny box (considered as light) and in a dark box. Also two alternatives were considered: measurements taken with a natural light source (function "S") and artificial light source (function "F"). The photocell was installed in six positions: paralell to the ceiling and floor and to four walls/barriers and the mean result was calculated (Janowski 1978, Kośla 2011). On the basis of the results of light intensity measurements in the buildings and outside, the room lighting coefficient was calculated (Kołacz and Dobrzański 2006, Kośla 2011).

Statistical analysis was done using the Statistica 5.0™ programme, ANOVA module. The significance of differences between the experimental groups was calculated using the LSD test (least significant differences) or Tukey's test.

RESULTS AND DISCUSSION

The new stable was built in 2003 together with the adjacent riding school. A shorter wall of the school adjoins the long stable wall from the north-east side. Due to that there are no windows on that side of the stable so one row of boxes is lighted only with artificial light. Hopper windows (18) are only on the south-west side at the height of 2.15 m from the floor. It is a safe height, so the window panels do not need any extra protection. However, their location near the roof limits the natural light inflow (Janowski 1978, Kołacz and Dobrzański 2006, Kośla 2011).

The location of windows only on one wall caused the uneven lighting with natural light of the entire stable. Boxes under the windows are clearly lighter than those situated on the other side. Results of the intensity of lightening confirm that phenomenon (Table 1). Artificial lightening decreases light deficit, however, it results from the observations that artificial light was turned on only when the light was needed by the users of horses (for grooming or saddling a horse before the training). Each window is of a rectangle shape with the glass surface of 0.68 m^2. There are two windows in each box.

The building interior lightening was calculated from the ratio of the window surface to the floor and it amounted to 1 : 21.9. Lightening standards for breeding horses and for competitive horses is 1 : 10 (Jodkowska 2007) or 1 : 12 (Kośla 2011) and for other horses it is 1 : 15 (Jodkowska 2007). Only for working horses which most of the day spend outside the stable the accepted ratio can be 1 : 20 (Kośla 2011).

The old stable is an adapted farm building. Windows are on both long walls and on a short south-west wall. Their shape is a standing rectangular of 122 cm over the floor on the short wall (7 windows) and 172 cm on the long walls (12 windows). Due to a low location of windows they are protected with metal bars. The surface of glass panels is 0.42 m^2 (7 windows) and 0.62 m^2 (12 windows). The degree of stable lightening calculated as a ratio of window to the floor surface amounted to 1 : 46.7. It shows that the window surface is too

TABLE 1. Seasonal average light intensity (lx)

Light	Corridor		Dark box		Sunny box		Outside
	the new stable	the old stable	the new stable	the old stable	the new stable	the old stable	
The summer season							
Natural	37.0	114.0	4.2	75.0	68.8	98.3	8 850.0
Artificial	138.8	106.7	13.8	49.8	61.3	95.8	8 850.0
The autumn season							
Natural	20.5	10.7	2.5	34.5	103.7	57.3	1 360.0
Artificial	138.3	41.3	13.0	40.7	118.2	71.0	1 360.0
The winter season							
Natural	1.4	11.0	0.5	30.3	5.6	36.8	780.0
Artificial	13.8	46.8	1.7	67.2	7.3	80.0	780.0

small in relation to the recommended standards (Kołacz and Dobrzański 2006, Jodkowska 2007, Pirkelmann et al. 2010, Kośla 2011). Table 1 shows a comparison of results describing light conditions inside and outside the stables depending on the site of the measurements taken distinguishing between natural and artificial light. The obtained results confirm the division into the, so-called, light and dark side of the stable (Fig. 1).

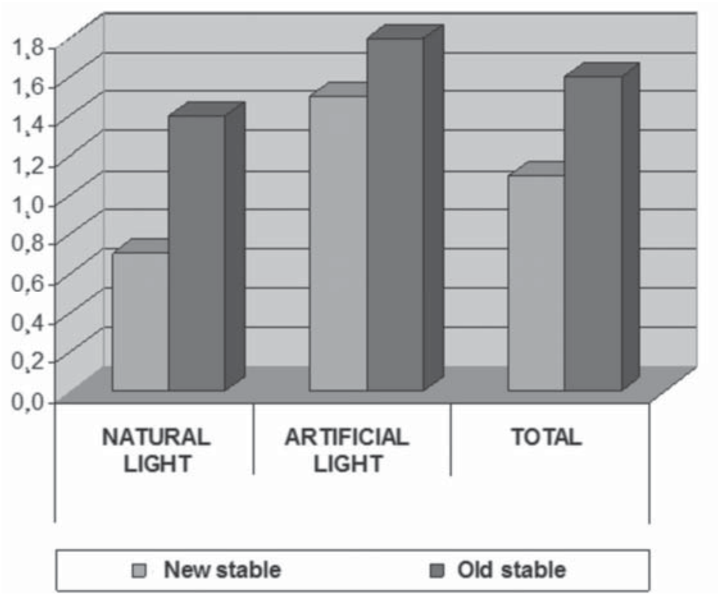

FIGURE 1. Room lighting index (%)

Good stable conditions ensuring animal welfare include a complex of physico-chemical parameters of the building microclimate. The most important of them from the animal hygiene point of view are: air temperature and humidity, air movement and its cooling force, atmospheric pressure and lightening.

The averaging results of the temperature measurements in the new and old stable and outside are presented in Table 2. Statistical calculations show that the difference in temperature between the new and old stable at 7 a.m. in autumn is significant at $p \leq 0.05$. The remaining values of temperature in the new and old stable did not show any significant differences. In winter the temperature drop below the required minimum value was observed a few times but it was more frequent in the old stable. On the other hand, the tendency to exceed the maximum value in summer was revealed by the results of the measurements taken in the new stable. The optimum scope of temperatures recommended for horses which do not cause any welfare disturbances is from 5 to 28°C (Rozporządzenie 2003, Kołacz and Dobrzański 2006).

Horses tolerate lower values of temperature much better than higher both while resting, moving or during activities. In the moderate values of temperature the mechanisms and processes responsible for the thermal balance are

TABLE 2. Seasonal values of air temperature (°C) at 7 a.m., 1 and 7 p.m.

Air temperature (°C)	07:00			13:00			19:00		
	the new stable	the old stable	outside	the new stable	the old stable	outside	the new stable	the old stable	outside
The summer season									
Minimum	21.8	20.7	23.7	23.8	25.2	33.1	24.7	23.9	21.2
Average	23.0	22.2	26.0	26.0	22.5	37.0	27.0	26.1	25.9
Maximum	25.2	23.3	29.8	28.5	29.25	40.1	28.6	28.1	28.6
The autumn season									
Minimum	12.5	4.5	1.0	3.9	4.0	1.6	7.6	5.5	0.9
Average	13.9	8.7	4.6	12.6	11.6	11.0	12.4	10.8	7.7
Maximum	15.9	11.8	9.2	16.8	16.5	16.2	16.0	16.0	13.3
The winter season									
Minimum	4.6	2.9	–0.2	5.3	2.6	0.2	2.5	3.5	–1.3
Average	8.3	5.6	1.5	6.3	4.9	2.5	5.8	5.1	1.4
Maximum	11.3	7.4	2.9	7.5	7.0	4.1	9.6	7.5	3.7

able to maintain the organism temperature within a safe range (Wolski 1987, Golachowski 2005).

Air humidity and temperature in the farm buildings are particularly important for the welfare and health state of horses (Kołacz and Dobrzański 2006, Kośla 2011). In case of the air temperature drop its relative humidity increases. A very thorough measure of air humidity is the comparison of air temperature and dew-point temperature (Kołacz and Dobrzański 2006, Kośla 2011). The determined upper limit of the relative humidity for horses in Poland is 80% (Lewandowski 1997, Kołacz and Dobrzański 2006, Kośla 2011).

A too high humidity level affects unfavourably the microclimatic conditions in the building and affecting negatively the elements of its construction may cause biodegradation of the building materials (Wiśniewska 2005).

Mean relative humidity values for stables and seasons are compared in Table 3. No significant differences were noted in the air relative humidity values in the new and old stable. Air humidity showed an increasing tendency in the afternoons and evenings reaching in one of the measurements the acceptable value of 80% – Figure 2 (Fedorski 2003, Fiederowicz 2006, Kołacz and Dobrzański 2006).

The dew-point phenomenon affects in a significant way the humidity conditions in the farm building and thus the animal welfare. In the case when cold atmospheric air gets into the stable through the ventilators then the dew-point

TABLE 3. The mean values for relative humidity (%) in different seasons at 7 a.m., 1 and 7 p.m.

Season	07:00			13:00			19:00		
	the new stable	the old stable	outside	the new stable	outside	the old stable	the new stable	the old stable	outside
Summer	68.79	64.94	52.60	46.35	48.38	26.32	48.48	50.16	45.13
Autumn	73.58	68.80	86.01	65.82	67.92	66.81	64.82	69.25	75.54
Winter	70.60	72.00	86.76	68.46	73.44	80.34	70.40	71.36	82.20

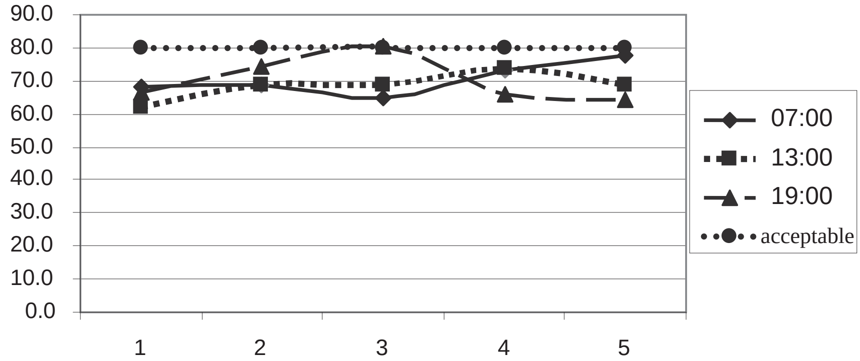

FIGURE 2. The values of relative humidity (%) in the new stable in the winter season

temperature may be exceeded, especially when the horse density is high (Kośla 2011). It leads to the cooling of their organisms and their susceptibility to cold increases. A significant difference of the dew-point temperature (Table 4) in the new and old stable was observed in the autumn season at 7 a.m. ($p \leq 0.05$).

The results of the LSD test confirm the statistically significant differences in the air cooling force (Table 5). A highly significant difference ($p \leq 0.01$) between the cooling force in the new and old stable was noted in the summer season at 7 a.m. and in the autumn season also at 7 a.m. In the winter season no statistically significant differences were observed. While comparing the air movement velocity in the new and old stable (Table 6), the obtained results proved to be statistically significant at 7 a.m. in the summer season at $p \leq 0.01$ and in the autumn season at the significance level $p \leq 0.05$.

Mean values of atmospheric pressure for a given season formed a characteristic pattern. The highest readings were obtained in the summer season, a bit lower in the autumn season and the lowest in winter.

TABLE 4. Seasonal values the temperature of dew point (°C) at 7 a.m., 1 and 7 p.m.

Tempera-ture (°C)	07:00			13:00			19:00		
	the new stable	the old stable	outside	the new stable	the old stable	outside	the new stable	the old stable	outside
The summer season									
Minimum	15.3	12.7	12.7	9.2	12.0	7.7	11.5	12.0	7.6
Average	17.2	15.3	15.3	14.0	14.7	13.1	14.8	14.5	12.3
Maximum	19.5	18.2	17.5	19.8	20.3	19.6	18.2	18.3	17.2
The autumn season									
Minimum	6.8	–1.4	–1.9	–0.4	0.0	–0.5	0.4	–1.1	–3.5
Average	9.3	3.3	2.6	6.3	4.8	4.7	5.9	5.3	3.9
Maximum	12.1	7.2	6.8	11.6	10.9	10.3	11.0	11.5	10.5
The winter season									
Minimum	–0.6	–1.6	–2.2	0.0	–1.1	–1.9	–3.3	–0.9	–4.2
Average	2.7	0.5	–0.7	0.7	0.3	–0.7	0.1	0.1	–1.7
Maximum	6.7	4.1	2.0	3.2	3.5	2.1	3.6	2.3	2.2

TABLE 5. The average values of cooling from katathermometer ($W \cdot dm^{-2}$) at 7 a.m., 1 and 7 p.m. in different seasons

Season	Cooling ($W \cdot dm^{-2}$)								
	07:00			13:00			19:00		
	the new stable	the old stable	outside	the new stable	the old stable	outside	the new stable	the old stable	outside
Summer	1.82	2.52	2.14	1.99	1.53	1.57	2.12	1.95	2.68
Autumn	3.22	4.80	6.87	4.75	3.88	6.02	4.07	4.03	6.61
Winter	3.76	4.67	8.96	4.45	4.85	8.43	4.71	4.94	7.43

TABELA 6. The average and maximum values air speed ($m \cdot s^{-1}$) at 7 a.m., 1 and 7 p.m.

Air speed ($m \cdot s^{-1}$)	07:00			13:00			19:00		
	the new stable	the old stable	outside	the new stable	the old stable	outside	the new stable	the old stable	outside
The autumn season									
Average	0.13	0.29	0.71	0.54	0.22	0.79	0.27	0.20	0.80
Maxi-mum	0.28	0.46	1.58	1.42	0.62	1.28	0.46	0.41	1.32
The winter season									
Average	0.10	0.17	1.13	0.16	0.18	1.01	0.19	0.22	0.65
Maxi-mum	0.25	0.32	2.09	0.33	0.28	2.03	0.46	0.56	1.68

CONCLUSIONS

1. Thermal conditions in both stables do not always agree with the standards. In the winter season a temperature drop below the required minimum value was observed a few times, more frequently in the old stable. On the other hand, in summer a tendency to exceed the maximum value was observed in the new stable.
2. Low intensity of natural light caused by architectural causes should be compensated with artificial light. Unfortunately most of the day horses were kept in the stable with the lights turned off. Especially in the new stable boxes without windows should be additionally lighted.

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Streszczenie: *Dobrostan koni oceniony z wykorzystaniem badań wybranych parametrów mikroklimatu stajni.* Celem przeprowadzonych badań była ocena dobrostanu koni na podstawie badania wybranych parametrów mikroklimatu stajni. Badania i pomiary przeprowadzono na terenie kompleksu hippicznego Wolica SGGW. Obiektami badań były dwa budynki stajni wykazujące różnice pod względem pierwotnego przeznaczenia, położenia, wymiarów, oświetlenia, warunków mikroklimatycznych. Badania zostały przeprowadzone w okresie trzech sezonów roku: letnim, jesiennym i zimowym. Oceniono czynniki kształtujące mikroklimat stajni, tj. temperaturę powietrza, wilgotność względną, prędkość i siłę oziębiającą powietrza, rodzaj i intensywność oświetlenia, a otrzymane wyniki zestawiono z obowiązującymi normami. Uzyskane wyniki wskazują, iż parametry są zgodne z zaleceniami zoohigieny i tylko sporadycznie przekraczają normy. Dobrostan był zachowany.

MS. received in November 2013

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