ACTA SCIENTIARUM POLONORUM *Acta Sci. Pol., Zootechnica 12 (4) 2013, 79–86*

EVALUATION OF SELECTED PHYSICAL PARAMETERS OF AIR IN AUTUMN IN STABLES OF NOWIELICE STUD FARM

Agnieszka Prokulewicz, Agnieszka Tomza-Marciniak

West Pomeranian University of Technology, Szczecin, Poland

Abstract. The aim of this study was to evaluate the temperature and humidity of air and light conditions in autumn in SK Nowielice stables. This study did not reveal any aberrancies from proper zoohygienic standards and thus did not decrease in horse welfare in autumn.

Key words: horse, physical air parameters, stable

INTRODUCTION

Microclimatic conditions in stable are some of the most important factors affecting horse welfare and profitability of raising and breeding. Apart from physical, chemical and biological parameters in the livestock buildings, also other factors clearly influence the stable's microclimate, such as outdoor climate, stocking, heat insulation and ventilation [Wolski 1988].

Previous studies on this issue showed numerous aberrancies from normative conditions of horse breeding [Pietrzak, Tietze 1999, Kupczyński, Mazurkiewicz 2004, Bombik et al. 2009, 2011 a, 2011 b].

The air temperature changes according to the time of day, season and current insolation [Pirkelmann et al. 2010]. Within the livestock building, with stable-grazing husbandry, the highest temperature is noticed in the morning and the lowest occurs in the afternoon. Distribution of temperature indoor is always unequal. The space under the ceiling is the warmest while lairs are usually the coldest

Corresponding author – Adres do korespondencji: dr Agnieszka Tomza-Marciniak, West Pomeranian University of Technology in Szczecin, Department of Animal Reproduction Biotechnology and Environmental Hygiene, Doktora Judyma 6, 71-466 Szczecin, Poland, e-mail: agnieszka.prokulewicz@zut.edu.pl

locations inside a stable. Also the temperature against the walls may differ from the one in central parts of building even up to 5°C [Kośla 2011].

Horses have a very high muscle mass, which protects it from freezing. Feeling of cold (with low air temperature and high relative humidity) causes increased blood flow in muscles to escalate inner temperature and ensure appropriate activity of main organs [Jurd 1999].

Kolbuszewski and Rokicki [1988] report that an optimal temperature range for horses must take into account breed, sex, age, physiological status and type of usage. Horses perform better with lower temperatures than with the heat. However in seriously unfavorable conditions the problem with excessive temperature lost or thermal recirculation may appear. This effect is intensified particularly by simultaneous low air temperature and high humidity.

Appropriate temperature in a stable determines proper intake and consumption of food, which influences on equine healthiness. Temperatures exceeding optimal values impair fertility in horses. Organism overheating causes i.a. reduction in semen quality, suppression of estrus and decreased *libido* [Betlejewska-Kadela 1990].

Horses, according to climatic adaptation, may exist in wide range of temperatures. Fiedorowicz [2007 b] recommends 5–15°C as an optimal temperature for stables. The wider range from 5 to 28°C is suggested in the Regulation of Ministry of Agriculture and Rural Development (Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 2 września 2003 r. w sprawie minimalnych warunków utrzymywania zwierząt gospodarskich [DzU nr 167, poz. 1629, z późn. zm.].

Horses, moist floors and excrements (feces and urine) are main humidity sources in a stable [Fiedorowicz 2004 a]. The amount of water vapor incoming into a stable with fresh air equals from 5 to 15% of total water vapor inside a building. Wet surfaces vaporization may reach even up to 25% of physiological evaporation [Dobrzański, Kołacz 1996]. A total absence or malfunction of ventilation system, too high stocking density and improper stable construction are common causes of exceeded norms for relative humidity [Fiedorowicz et al. 2004 a]. High water content in the air with low temperature cause decrease in appetite, cold, rheumatism as well as bronchi and lung diseases [Fiedorowicz, Łojek 2002].

Illumination is an important factor for microclimate in livestock buildings because it influences on animals vitality and productivity as well as technical condition of a building. Upon illumination the temperature and humidity of air change [Marciniak 2008]. The impact of lighting on animals manifests in increased humoral immunity. This process results in growth of γ-globulin fraction in blood serum and cellular immunostimulation likewise. [Fitko et al. 1991]. Minimal illumination calculated from the ratio of glazed window area to floor surface (W:F) should equal: 1:20 for replacement and not less than 1:15 for older horses. Artificial li-

ghting factor in stables lit with light bulbs shall reach 14 to 20 W · m^{-2} for farm horses and 8 to 16 W · m^{-2} for workhorses. The level of stable illumination depends not only on number and power of artificial light sources but also on their type and location [Fiedorowicz et al. 2004 a].

It should be noted that both in European and Polish legislation no direct act about equine husbandry is present. This suggests that, according to EU directive, individual standards for horses should be developed.

The aim of this study was to evaluate selected physical air parameters in autumn in stables of SK Nowielice.

MATERIALS AND METHODS

Horse Stud Farm Nowielice is currently breeding Polish Half Bred Horses (SP). Our study was conducted in 7 stables located within the farm. In analyzed buildings 89 horses altogether were kept, including: 12 mares with colts, 25 individuals from the replacement group and 40 mature, sport horses. First object was a box-stall stable for broodmares. According to weather conditions these animals were kept in the open yard. Objects 2 and 3 were freestalls for the replacement group, which was also allowed to use the open yard and a grassy paddock. Another object was a sport stable with boxes located in both sides of a building no. 4 for 7 horses which did not use paddock. These animals were ridden for at least 1 hour daily. Stable no. 5 with unilateral boxes was prescribed for 5 sport horses. Object 6 contained 4 boxes located bilaterally for sport- and reproduction stallions. The last building no. 7 was the biggest stable containing 27 boxes.

The temperature and humidity in autumn were measured with BIOTERM 144609 thermo-hygrometer. Measurements were conducted three times a day at 7.00, 13.00 and 19.00, in three different locations (at the entrance, in the middle and at the exit of a building) at the height of a horseback. Photoclimatic conditions were estimated by calculating levels of: (a) natural illumination (glazed window area to floor surface ratio; W:F) and (b) artificial illumination (number and power of light bulbs assigned to 1 m^2 surface; W · m^{-2}).

RESULTS AND DISCUSSION

Air humidity and temperature are the most relevant microclimatic parameters to evaluate in equine quarters. However numerous deviations from correct levels of these parameters are observed. Farmers usually do not realize the fact that air moisture capacity decreases with its temperature, respectively [Fiedorowicz et al. 2004 b]. Vapor condensation on construction elements in winter is an exact in-

dicator of unacceptable excess of optimal air humidity. Such situation results in stable construction decay and supports fungal development [Fiedorowicz 2007].

As shown in Table 1, the highest temperature in all objects was noted in midday. During that time horses from stables 1, 2 and 3 were kept in open yard. Moreover, the highest external temperature was noticed at that time of the day, which indicates a high correlation between external and internal temperature. Measurements conducted at 7.00 and 13.00 showed highest values of tested parameter in buildings in which no animals were present. Maximal difference between average external and internal temperature was observed in evening hours. According to Pirkelmann et al. [2010] the difference between mentioned values shall not exceed more than 3°C.

Table 1. Air temperature (°C) in following stables

Tabela 1. Temperatura powietrza (°C) w stajniach

Parameter Parametr	Hour of measurement Godzina pomiaru			Average for objects Średnie dla obiektów
	7.00	13.00	19.00	
Object no. 1 – Obiekt nr 1	11.2	14.8	11.5	12.5
Object no. 2 – Obiekt nr 2	11.4	14.6	11.9	12.6
Object no. 3 – Obiekt nr 3	12.0	14.9	12.4	13.1
Object no. 4 – Obiekt nr 4	10.7	14.2	12.8	12.6
Object no. 5 – Obiekt nr 5	10.7	14.1	12.7	12.5
Object no. 6 – Obiekt nr 6	10.2	13.8	12.4	12.1
Object no. 7 – Obiekt nr 7	10.7	13.4	11.5	11.9
Average for hour of measurement Średnie dla godzin pomiarowych	11.0	14.3	12.2	

Morgan [1997] and Morgan et al. [1998] suggest to maintain temperature in a stable at a level of 5 to 25°C in summer and 8 to 10°C in winter, respectively. In all objects analyzed the temperature did not differ significantly from recommended standards of Ministry of Agriculture and Rural Development (Directive of Ministry of Agriculture and Rural Development of the Republic of Poland, 02 September 2003, about the minimal livestock animals-keeping standards). Similar results were obtained by Bombik et al. [2011 a] who concluded that majority of physical air parameters like: temperature, relative humidity, air speed and refrigeration reached minimal values for horse breeding.

With reference to Directive of Ministry of Agriculture and Rural Development (Directive of Ministry of Agriculture and Rural Development of the Republic of Poland, 02 September 2003, about the minimal livestock animals-keeping standards), concerning minimal conditions of horse breeding the highest acceptable air humidity in stable should not exceed 80%. Fiedorowicz [2007] says that relative humidity recommended in EU shall achieve 70%.

Within examined stables average relative humidity for hours of measurement ranged between 75.0 to 79.5%. The lowest value was noted in objects 5 and 6 in morning hours (Table 2). Values from 80 to 81% were detected in stables no. 1, 2, 3 and 7.

Table 2. Relative humidity (%) in following stables

Tabela 2. Wartości wilgotności względnej powietrza (%) w stajniach

Object no. Obiekt nr	Hour of measurement Godzina pomiaru			Average for objects Średnie dla obiektów
	7.00	13.00	19.00	
1	77.3	78.7	81.0	79.0
2	76.3	78.0	80.7	78.3
3	77.0	79.3	80.0	78.8
4	74.3	77.0	78.0	76.4
5	71.3	75.3	77.3	74.6
6	71.0	75.7	78.7	75.1
7	78.0	79.7	81.0	79.6
Average for hour of measurement Średnie dla godzin pomiarowych	77.3	78.7	81.0	79.0

According to Fiedorowicz and Łojko [2002] and Fiedorowicz [2007] recommendations concerning illumination for horses in Poland and EU differ slightly. Directive of Ministry of Agriculture and Rural Development (Directive of Ministry of Agriculture and Rural Development of the Republic of Poland, 28.06. 2010, about minimal livestock animals-keeping conditions different from the protection standards defined by european directives) concerning acceptable breeding conditions for animals not specified in European regulations [Dz.U. nr 116, poz. 778] does not determine a minimal illumination level in a stable. In Poland 7% illumination is suggested (glazed window area to floor surface ratio) whereas in EU 5–7% illumination is recommended with limitation that there should be a 2.5–3.0 $W \cdot m^{-2}$ source of light inside a building [Fiedorowicz, Łojek 2002, Fiedorowicz 2007]. Pirkelmann et al. [2010] states that for replacement W:F ratio may reach even 1:20. Kośla [2011] points an optimal power of tungsten light in stable should be equal to 8 $W \cdot m^{-2}$ for workhorses and up to 16 $W \cdot m^{-2}$ for mares with colts.

Maintenance system in stable no. 1 (pregnant and mother mares) did not allow to install such powerful lighting because of mares' welfare before parturition, which usually occurs at night. They feel safest in dusk [Prawocheński 2010]. Level of illumination should be high for colts however natural light is more proper than artificial which shall only ensure visibility and allow infants to rest.

This research showed that only object no. 1 with mares and colts fulfilled Polish requirements for natural illumination. European recommendations concerning both natural and artificial illumination were complied by stables no. 1, 4 and

5. Construction of all objects definitely provided enough amount of natural light mainly due to entrance gates which were opened during the day. Moreover in stables with lowest natural illumination level (objects 2 and 3) the highest intensity of artificial illumination was noticed (3.0 W · m^{-2}). From dawn to dusk horses from stables 1, 2 and 3 were kept in the open yard.

Table 3. Natural and artificial illumination in following stables

Tabela 3. Wartości oświetlenia naturalnego i sztucznego w stajniach

Object no. Obiekt nr	Stable surface, m² Powierzchnia stajni, m²	Glazed window area, m² Oszklona powierzchnia okien, m²	Natural Illumination, W · m⁻² Oświetlenie naturalne, W · m⁻²		Artificial illumination, W · m⁻² Oświetlenie sztuczne, W · m⁻²
			W:F	%	
1	428	30.20	1:14	7	1.2
2	100	2.71	1:37	3	3.0
3	100	2.71	1:37	3	3.0
4	121	5.50	1:22	5	2.5
5	81	3.50	1:23	4	2.5
6	112	5.50	1:20	5	1.8
7	437	21.50	1:20	5	1.4

CONCLUSIONS

Our studies conducted in autumn showed that selected physical air parameters in SK Nowielice objects complied the zoohygienic requirements. Average temperature within the stables ranged between 10.2 to 14.9°C while relative humidity ranged between 71 to 81%. Natural and artificial illumination recommendations are varied and depend on structural condition of individual building.

This research showed that physical air parameters in examined objects did not affect on equine welfare in autumn.

REFERENCES

Betlejewska-Kadela K., 1990. Wpływ klimatu na płodność i użytkowanie koni [Effect of climate on fertility and usage of horses]. Koń Pol. 4, 7–9 [in Polish].

Bombik T., Górski K., Bombik E., Malec B., 2009. Porównanie warunków utrzymania koni w stajni stanowiskowej i boksowej [Comparison of breeding conditions in box- and freestall stables]. Acta Sci. Pol., Zootechnica 8 (1–2), 3–10 [in Polish].

Bombik E., Bombik T., Frankowska A., 2011 a. Evaluation of selected parameters of horse stabling environment in box-stall stables. Acta Sci. Pol., Zootechnica 10 (4), 13–22.

Bombik E., Bombik T., Frankowska A., 2011 b. Ocena warunków utrzymania koni w stajniach boksowych. Konf. Nauk. Środowiskowe zagrożenia zdrowia ludzi i zwierząt [Conference Environmental threats of human and animal health]. Szczecin 18 listopada 2011, ZUT Szczecin [in Polish].

Dobrzański Z., Kołacz R., 1996. Przewodnik do ćwiczeń z zoohigieny [Zoohygienic excercise guide] Wyd. AR Wrocław [in Polish].

Fiedorowicz G., Łojek J., 2002. Farm Standards: Porównanie polskich i unijnych przepisów- analiza prawna w celu wypracowania standardów z zakresie hodowli koni [Comparison of polish and european directives – legal analysis to estimate horse–keeping standards]. Praca zbiorowa. IBMER i Duńskie Centrum Doradztwa Rolniczego [in Polish].

Fiedorowicz G., Łojek J., Clausen E., 2004 a. Budowa nowych stajni i modernizacja budynków inwentarskich dla koni [Architecture of new stables and modernization of lifestock buildings for horses]. Prz. Hod. 12, 20–21[in Polish].

Fiedorowicz G., Łojek J., Clausen E., Finderup J., Birkkjaer K.O., 2004 b. Poradnik. Systemy utrzymania koni [The Guide: Horse-keeping systems]. IBMER i Duńskie Służby Doradztwa Rolniczego [in Polish].

Fiedorowicz G., 2007. Wymagania dotyczące warunków środowiskowych w chowie koni [Environmental condition requirements of horse breeding]. Probl. Inż. Rol. 4, 133–138 [in Polish].

Fitko R., Kądziołka A., 1991. Patologia fizjologiczna zwierząt [Animal physiological pathology], PWRiL Warszawa [in Polish].

Jurd R.D., 1999. Biologia zwierząt [Animal Biology]. PWN Warszawa [in Polish].

Kolbuszowski T., Rokicki E., 1988. Wybrane zagadnienia z medycyny weterynaryjnej [Selected issues of veterinary medicine]. Fundacja Rozwoju SGGW Warszawa [in Polish].

Kośla T., 2011. Metodyka badań z higieny zwierząt i prewencji weterynaryjnej [Methodology of animal hygienic research and veterinary prevention]. Wyd. SGGW, Warszawa [in Polish].

Kupczyński R., Mazurkiewicz J., 2004. Ocena warunków mikroklimatycznych w dwóch obiektach hodowli koni [Evaluation of microclimatic conditions in two horse-keeping objects]. Zesz. Nauk. Akad. Rol. Wroc., Zootech. LI (501), 165–171 [in Polish].

Marciniak A.M., 2008. Ocena poziomu oświetlenia naturalnego w oborach wolnostanowiskowych [Evaluation of natural illumination level in freestall sheds]. Probl. Inż. Rol. 2, 109–113 [in Polish].

Morgan K., 1998. Thermoneutral zone and critical temperatures of horses. J. Therm. Biol. 23, 59–61.

Morgan K., Ehrlemark A., Sallvik K., 1997. Dissipation of heat from standing horses exposed to ambient temperatures between –3°C and 37°C. J. Therm. Biol. 22, 177–186.

Pietrzak S., Tietze M., 1999. Ocena warunków zoohigienicznych w wybranych stajniach Lubelszczyzny [Evaluation of zoohygienic conditions in selected stables of Lublin region]. Mat. Symp. Aktualne kierunki hodowli i użytkowania koni w Europie. AR Kraków, 17–19 września, 490–496 [in Polish].

Pirkelmann H., Ahlswede L., Zeilter-Feicht M., 2010. Hodowla koni [Horse Breeding]. RM Warszawa [in Polish].

Prawocheński R., 2010. Hodowla Koni [Horse Breeding]. PWRiL Warszawa [in Polish].
Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 2 września 2003 r. w sprawie minimalnych warunków utrzymywania zwierząt gospodarskich [Directive of Ministry of Agriculture and Rural Development of the Republic of Poland, 02 September 2003, about the minimal livestock animals-keeping standards] [Dz.U. Nr 167, poz. 1629, z późn. zm.] [in Polish].
Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 28 czerwca 2010 w sprawie minimalnych warunków utrzymania zwierząt gospodarskich innych niż te, dla których normy ochrony zostały określone w przepisach Unii Europejskiej [Directive of Ministry of Agriculture and Rural Development of the Republic of Poland, 28 June 2010, about minimal livestock animals-keeping conditions different from the protection standards defined by european directives.] [Dz.U. Nr 116, poz. 778] [in Polish].
Wolski L., 1988. Mikroklimat w budynkach inwentarskich [Microclimate in livestock buildings]. PWN Warszawa [in Polish].

OCENA WYBRANYCH PARAMETRÓW FIZYCZNYCH POWIETRZA W OKRESIE JESIENNYM W STAJNIACH STADNINY KONI NOWIELICE

Streszczenie. Celem badań była ocena temperatury i wilgotności względnej powietrza oraz oświetlenia w okresie jesiennym w stajniach SK Nowielice. Przeprowadzone badania w stajniach SK Nowielice nie wykazały odchyleń analizowanych parametrów od norm zoohigienicznych i nie powodowały obniżenia dobrostanu koni w okresie jesiennym.

Słowa kluczowe: fizyczne parametry powietrza, koń, stajnia

Accepted for print – Zaakceptowano do druku: 10.12.2013