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THE ANNEX TO THE KNOWLEDGE OF MICROCLIMATE CONDITIONS OF SPORTS HORSES ACCOMMODATION

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Abstract: An adequate accommodation of sport horses implies the appliance of all construction, zootechnical and hygienic norms. Stables for horses should provide optimal microclimatic conditions for horses, social contact with other horses, unrestricted access to food and water, as well as to reduce the risk to injury to a minimum. Stables are essential for wellbeing of horses, because they spend a significant part of the day in them. Lights, temperature, humidity, air flow, concentration of gases and dust, hygiene and noise intensity in the areas where the animals are, must be within limits that are not harmful for horses. Satisfying optimal microclimatic conditions in the horse stables represent one of the most important items when projecting a facility. The aim of this paper is to highlight the significance of adequate accommodation for horses in accordance with the natural ethological characteristics of horses as well as to describe the most important ambient parameters in the closed type facilities.

***Keywords**: sport horses, stables, microclimatic parameters*

INTRODUCTION

Equestrian sport and horse breeding represent one of the indicators of economic development of the country and the life quality of the population in the 21st century, and that is the reason why a horsemanship is the most represented in the most economically developed countries of the world. Horses are mostly used in equestrian sports (gallop and trotting races), hurdles (show jumping) and dressage sport, and significantly less for recreational riding, as a help for people with development disabilities, tourism and as a working animals. In the past, horses were mostly used for warfare and transportation, and only after that for competition and hunting (Lang, 2005).

Horses, as the first domesticated animals are typical representatives of the herd ruled by hierarchy, so in the wild the herd consists of several mares and foals, and one stallion that is an alpha of the heard or the horse leader. Among the mares, the first place is occupied by the alpha mare which leads the herd to the water, food and when running, and the stallion is at the end of herd and it drives the remaining members forward. After domestication, the man changed the life of horses in herds and started to breed them in stable controlled conditions trying to make the microclimatic conditions of accommodation as close to physiological needs of horses as possible, as well as to provide appropriate accommodation, nutrition and care for horses. From the former use of horses for work in agriculture, transportation and warfare, the present day horses are mostly used for sports.

Short extracts from the historical development of equestrian sport in Serbia

The first equestrian association, whose main activity was proper riding competition and dressage training, was founded in Principality of Serbia in Belgrade in 1885, and sometime later in Šabac in 1888 and then in Niš, Kragujevac and Zaječar in 1898. Tournament competitions in speed were held several years later, so the first trotting races were held in Belgrade in 1909, and dressage riding and hurdles (show jumping) in 1911. Equestrian Association of Serbia was founded in 1947. and after breakup of Yugoslavia, The Association for Equestrian Sport of Serbia for Olympic and FEI disciplines (Federation Equestre International) was founded in 2002. The main activity of the association is to hold gallop and trotting races, and Serbia participaded in the olimpic dressage riding discipline for the first time in 2012 (Šiljak V., 2007).
There are no precise data on exact number of specific categories of horses in the Republic of Serbia, but according to official data of Statistical Office of the Republic of Serbia from 2019, about 14.000 horses of different breeds as well as about 6.000 mares and fillies (females below the age of 3) are bred in our country. Compared to 1955 when Yugoslavia had 519.000 horses, the number of horses decreased by 97%, and compared to 290.000 horses in 1975 it is a 95% decrease in number of horses. According to official data , only about 19.000 head of horses were tagged , of which there are 1.293 mares and 67 stallions (Statistical Office of the Republic of Serbia, 2019).

Horse accomodation

An adequate accommodation, besides training and nutrition of horses, is one of the most significant factors for achieving sports results. Stables for keeping sport horses should be with stalls of suitable dimensions which are comfortable for lying down, moving, feeding and should have enough light

and fresh air. Proper accommodation implies the realization of all construction, zootechical , hygienic norms and wellbeing of horses.That is the only way to create preconditions for implementation of other zootechnological measures, and all that in order to achieve good sports results in competitions.
Facilities for horses accommodation on horse farms consists of a main stable where there are boxes for different age categories and outbuildings that are used as a placement for food, manure, mechanization, ring (exercise space) etc. The main feature of the horse farm is that the separation of the head is performed according to gender, into foals and yearlings, and that is why all categories have got separate facilities. When keeping horses in stables, where there is usually smaller number of heads, it is common for all heads to stay in the same facility and there is no strict division into breeding stock and offsprings (Brinzej, 1980; Pejić, 1996). In our country, the field of construction of facilities for horse breeding and keeping is defined by legal regulations (Official Gazette of RS, No. 81/2006).

There are several divisions of horse stables in the literature. In horse farms horses can be kept in individual stalls, in groups in stables and freely on the pasture. There is a similar division of stables according to microclimate, and based on it the stables are divided into: warm (closed), cold (open) and semi-open (one lateral side of the stable is open). The third division of the stables are based on the ability of the horse moving, and according to it the stables are divided into free way of keeping (individually or in groups) and individual keeping in the stalls on the leash. The free way of keeping horses has a number of advantages compared to other ways of keeping horses, because horses as social animals achieve better results in competitions. When you keep horses in groups, the optimal number of horses in the group is 10 heads. According to Ogrizek (1952), breeding horses on the pastures is the healthiest way to breed horses, because there is enough light, fresh air and movement for horses. Each horse needs at about 0.5 to 1.0 hectares of pastures with additional feeding or 1.25 to 2.5 hectares of pastures of appropriate quality if there is no additional feeding. We need to build awnings for horses on the pastures in order to protect them from sun, wind and natural disasters. The hight of a fence on pastures are from 1.4 m to 1.8 m, and are made of wood, hedges and metal constructions (Ograzek and Hrasnica, 1952; Pejić, 1996; Margić and Matković, 2011).

Today, horses are mostly bred in idividual stalls, which facilitates work of breeders for feeding , easier monitoring and care for horses. The stalls are facing towards the hallway and that way the horses have an opportunity for communicating and socializing with other heads in the stable. All the doors of the stalls open towards the stable hallway. Doors and windows are made of wood, and more recently of PVC material. For floors, which must not be slippery and must prevent injuries, we use asphalt, rubber backing and

combination of concrete and rubber backing (Lang, 2009). Each head in the stall should be provided with a minimum of 10 to 12 m^2 of lying space depending on the size of the horse, where the minimum floor area of a stall is calculated according to the formula:

3 x hight of the crest in meters - for wider side of a stall
1.5 x hight of the crest in meters - for narrower side of a stall

According to Pejić (1996), the size of the stall should be 3.5 x 3.5 up to 4 x 4 meters.The dimension of the stall for smaller horses are 3 x 3 up to 3 x 3.5 meters, while for larger horses they are 4.5 x 4 up to 4.5 x 4.5 meters and for mares with the foals 5 x 4 meters. The data from Table 1, which is based on the measured height of the crest with the Litin's stick, can be used for more precise determination of the area of the individual stalls.

Table 1. Dimensions of the individual stalls for horse accommodation (Sakač et al., 2010)

Height of the crest	**Area of the stall per head**	**Shorter side of the stall**	**Width of the stall**	**Height of the celling**
up to 150 cm	8.5 m²	220 cm	1.5 x height of the crest	260 cm
up to 165 cm	10 m²	250 cm	1.5 x height of the crest	260 cm
up to 175 cm	11 m²	260 cm	1.5 x height of the crest	270 cm
up to 185 cm	12 m²	270 cm	1.5 x height of the crest	300 cm
over 185 cm	14 m²	290 cm	1.5 x height of the crest	310 cm

Feeders and automatic drinkers in individual stalls are placed at a height of 1/3 of the hight of horse's crest, while in group keeping of horses we use group feeders where each adult horse should be provided with 60 to 70 cm of space. Cribs and hammocks are used for hay, and solid containers made of different materials (wood, plastic) are used for concentrated nutrients. The practical organization of work day in stables is based on the morning feeding

of horses with forage, then with concentrated food, and after the heads are submitted to care (cleaning with the brush), mucking out of the stall is performed. After exercise and work with horses, the heads are fed with hay or they are let to a pasture in the afternoon, and after that they are allowed a few hours of free time and rest. The third feeding of horses with concentrated nutrients or forage is done in the evening.

In practice, keeping horses on leash is combined with free way of keeping horses during which the horses are trained or are on the pasture. In the most countries of EU it is forbidden to keep animals tied in boxes, but temporary tying is allowed only during cleaning, breeding and during sports competition. Modern stables have an outlet for the movement of the horses, where the area of the outlet is twice as large as the floor area of the stall.Modern training stables, alonside outlet, are also equipped with automatic treadmills so that the heads in training can walk several times a day (Ivanković, 2004).

In group keeping, horses are allowed to have a social contact with other heads and a hierarchy is created among the heads in the group. This manner of breeding horses disables the breeder to feed and approach each horse individually, but the consumption of working hours is significantly lower compared to individual horse keeping. The floor area of a group stall depends on dimensions, i.e. on the height of the horse crest and it is in average from 10 m^2 to 12 m^2 per head, and an area of the outlet should be from 10 m^2 to 13 m^2 per head (Pollman, 2000).

The stable must be lit well, because the light is incredibly important factor for the health preservation as well as functioning of horses' reproductive cycle. The lenght of a daylight in the horse stable must not be less than eight hours with a light intensity of at least 40 lux. The recomendation is that the area of the window on the facility is about 5-10% of the floor area of the stable, and each stall has to have a window of dimensions 1.2 x 1 x 1 m. According to Ivanković (2004), in the practice it is typical for the area of windows on the facility to be from 1/15 to 1/20 of the total floor area.

The hygiene of the stable must be in the function of maintaining optimal microclimatic conditions, in order to preserve the health and wellbeing of horses. For that reason, horse stalls must be regularly cleaned and hygienically maintained (hot water, disinfectant). Straw and sawdust bedding as well as robber coverings are used in the stalls. It is recommended to use sawdust for a bedding because it does not contain bacteria or mold which could cause respiratory diseases. Inversely, straw contains organic dust which irritates the respiratory organs. The thicker the bedding, the better it absorbs the urine and it is less likely for a horse to injure itself when lying down and getting up. On modern horse farms, rubber floor coverings are most often used combined with sawdust.

Microclimatic conditions in the stable

In the closed type stables, optimal climate conditions are of great importance for the normal functioning of the organism, the health preservation and achieving good sports results of horses. Unlike open type stables, where complete control of climate parameters is not possible, in the closed type stables achieving optimal values of climate factors depends entirely on a man.

Temperature

As a herd animal that lives all around the world, a horse is very adaptable to climate differences and as a homoeothermal animal it is adaptable to changes in outdoor temperature in order to maintain its body temperature. Moreover, horses tolerate lower temperatures better than the higher ones, because in colder climate areas and during the winter, horsehair grows longer which protects them from cold (McCutcheon et al., 1999). Body temperature is a by-product of metabolism in all body tissues, whereby 60-70% of heat production at rest takes place in the heart, liver, kidneys and brain , although these organs have less than 10% of body mass. Metabolism and body heat production in horses are lowest between -10 and +10°C, while at a temperature of -40°C basal metabolism increases to over 140% (Sjaastad et al., 2016).

The optimal temperature in a horse facility depends on the breed, feeding intensity, humidity, number of animals and the health of horses. Horses are able to withstand temperatures ranging from -40°C to + 40°C, and critical temperatures are between -15°C and 10°C, whereby foals are more sensitive to low temperatures than adult heads (Hintz and Cimbaluk, 1994; Charles, 1994). Horses protect themselves from high outdoor temperature by sweating, which is a very efficient way of cooling, because basal energy of organism is spent on water evaporation from the surface of the skin. According to Guthrie and Lund research (1998), 2.4 MJ of heat is used for evaporation of 1 liter of water from the surface of a horse skin, which is equivalent to heat production during 2 minutes of intensive work. The optimal temperature interval, for most horse breeds, range between 10°C and 15°C (Guthrie and Lund, 1998).

Relative humidity

Relative humidity represents the ratio of the water content in the air and its water capacity, i.e. to what extent the air is saturated with water vapor. Humidity in the stable comes from horse breathing, urine and feces, bathing horses and cleaning the stable. Warmer air contains more water vapor than the cold one, and increased humidity over 80% causes respiratory disorders in horses, increases the content of harmful microorganisms in the air, and it also

leads to moisture condensation on the walls of the stable which causes corrosion and rotting of wooden elements. Optimal relative humidity in horses' facilities is 65-70% (Wathes, 1994; Pejić, 1996).

The content of the pollutants in the air of the horse stable

The content of the pollutants in the air of the stable is a very important factor in preservation of the health of horses, becuse horses live longer than most domestic animals, so the health of the respiratory organs are more critical for horses than other species of domestic animals. Also, horses are nowadays used for intensive work that requires maximum involvement of respiratory organs, and therefore they are more susceptible to respiratory diseases. The air in the poorly ventilated stables for horses contains various pollutants that originate from food, bedding and feces, and its concentration primarily depends on the ventilation of the stable. The most common air pollutants in horse stables are: ammonia, carbon dioxide, hydrogen sulfide, dust, microorganisms, endotoxins and other matters of organic and inorganic origin (Curtis et al., 1996).

Ammonia (NH_3) is the most common toxic gas released from the urine and manure and which in high concentration can cause pneumonia in horses, and in foals it can even cause death. The concentration of ammonia in the air increases with increasing of the temperature and humidity (Curtis et al., 1996).

Carbon dioxide (CO_2) concentration is caused by horse breathing and since it is specifically heavier than air, the highest concentration of this gas is found near the stable floor. The efficiency of the ventilation system in the stable is primarily measured by the content of carbon dioxide in the air (Curtis et al., 1996).

Hydrogen sulfide (H_2S) is a highly poisonous gas which is formed by decomposition of feces and whose increased concentration in the air can cause respiratory diseases.

Dust in the stable air consists of inorganic part (bedding, food) and organic part (bacteria, bacterial endotoxins, viruses, fungi and allergens). The most dangerous for horses is respiratory dust which can be inhaled and whose particle size is between 0,5-5 μm. Dust in the air works as a carrier for damaging microorganisms and it irritates the mucosa of the respiratory organs and eyes. Dust concentrations are twice as high if the straw is used as bedding compared to wooden sawdust or rubber coverings (Vandenput et al., 1997).

The concentration of ammonia must not exceed the value of 20 ppm or 13.93 mg/m^3, and the optimal value of ammonia in the stable air is up to 10 ppm or 6.96 mg/m^3 of the air. The maximum level of carbon dioxide that is allowed in the stables for horses is up to 3000 ppm or 5400 mg $/m^3$ of the air, while the optimal values are from 500 to 2000 ppm, considering that the level of CO_2 in

the outdoor air is 350-400 ppm. The maximum level of H_2S that is allowed is up to 0.5ppm or 0.68 mg/m^3 of the air, and dust in the stable air is 4 mg/m^3. The optimal level of H_2S in the stable air is only in traces, and of dust is from 0.2 mg/m^3 - 0.6 mg/m^3.

The most important factor in providing fresh air in the stables for horses is ventilation. The ventilation system affects the concentration of pollutants in the air, water vapor content and temperature values, so without appropriate ventilation the concentration of harmful matters increases in the stable air (Elfman et al., 2011). It is necessary to provide from 40 m^3 to 60 m^3 of air for horses a day, where the allowed air flow speed in the zone of the animals stay is from 0.4 to 0.8 m/s in summer, and about 0.2 m/s in winter. Approximately during summer months the air in the stable should be changed at least four times a day, and in winter at least twice a day. Modern horse stables use mechanical ventilation whereby fans create noise that must not be higher than 65 dBA (Ivanković, 2004; Elfman et al., 2011).

CONCLUSIONS

Accomodation of sports horses , besides nutrition, exercise and care is one of the most important factors for achieving good sports results. Horse facilities must be airy, with enough natural light, without harmful gases and dust, and projected in a way to allow breeder unrestricted access during feeding and care of the horses as well as maintenance and cleaning of the facility. Concentrations of gases, temperature values, dust and relative humidity must be within optimal limits, all in order to achieve good sports results.

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