

## CHARACTERISCS OF INDOOR MICROCLIMATE STATUS IN GOAT BARNs IN BOSNIA AND HERZEGOVINA

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### ABSTRACT

The aim of this paper is to explain microclimatic indicators in the winter inside buildings for of goat housing in Bosnia and Herzegovina. Data processed in this paper were collected from ten goat farms which are deployed throughout Bosnia and Herzegovina. In the housing facilities for goats for whose were determined the microclimate status, the average temperature was in the range of optimal values. Average airflow in facilities for goats in Bosnia and Herzegovina was below the 0.2 m/s during the winter period. The average relative humidity in the goat barns in Bosnia and Herzegovina ranged permitted values. The average determined concentration of ammonia in the air barn goat farm is located above the allowable limit. On based of established levels of CO<sub>2</sub> in goat barns in Kozara region of Bosnia and Herzegovina could be concluded that there is above the allowable limit. Reducing the levels of harmful gases in the facilities may be required in increasing the air change in buildings either natural or artificial ventilation.

**Key words:** goats, housing, winter, microclimate, gases

### INTRODUCTION

The goat is a kind of domestic animal that produces products such as milk, meat necessary for human nutrition, quality leather and sackcloth of which are used in clothes production, but also other things and manure that is used to improve soil fertility. Goat husbandry nowadays is characterized by three production systems: extensive, semi-intensive and intensive. Extensive system is characterized by low investment in facilities for goats. Goats are placed in inappropriate facilities during the winter and feed on shadows with minimum of available concentrate feedstuffs. Breeds held in this way belong to the group of primitive or natural breeds. Semi intensive way of goat housing and breeding implies something greater investment in facilities for the animals and complete diet. Breeds kept in this way belong to the group of crossbreeds between primitive and noble breeds, and can be bred noble breeds, which in this case achieved lower production. Intensive way of goat's breeding, means the keeping of animals throughout the year within the buildings in which construction was invested

more resources. Farms for intense way of goat production in its composition have all necessary facilities intended for smooth production technology. Goat breeds that are grown in this system it belongs to the group of noble race whose expression of genetic potential, in particular for the milk or meat production and those need necessary balanced diet. In order to preserve the health of animals, and therefore production, while keeping goats inside buildings, regardless of the breeding system is necessary to ensure adequate microclimate. Elements of microclimate prevailing in barns for goat housing define the environment in which the goats will spend its lifetime. It could be said that optimum microclimatic conditions, with their actions have beneficial effects on health of the animals, better feed utilization, and favorable metabolism and finally allow maximum delivery of planned production results. In practice, especially in extensive and semi-intensive way of goat breeding is not given enough importance to microclimate conditions inside buildings, what affects negatively the health and productivity of animals, which cannot be tolerated in intensive production.

The aim of this paper is to explain microclimatic indicators in the winter inside buildings for of goat housing in Bosnia and Herzegovina.

### **MATERIALS AND METHODS**

Data processed in this paper were collected from ten goat farms which are deployed throughout Bosnia and Herzegovina. Two farms were located on the route Sarajevo - Žepa, five farms are located in the Western Herzegovina in the area of municipalities Tomislavgrad and Široki Brijeg and three farms are around city of Banja Luka. Farms have had more than 50 goats belonging to the different production systems of goat production. Buildings that housed goats were purpose-built for that purpose or were adapted for keeping goats. Data that were taken on farms are: the dimensions of buildings, number and surface of windows, no ventilation Aperture on the walls and on the roof, the temperature inside the building, the temperature of the reservoir, the roof temperature, relative humidity, carbon dioxide concentration, the concentration of ammonia, lighting and air flow inside the building.

All dimensions in barns were measured by laser meter PCE-LDM 50 laser Measuring range from 0.05 to 50.0 m with tolerance of 1.5 mm. Temperature and relative humidity were obtained using thermal anemometer PCE – 423. Thermo-anemometer is one of the basic equipment for the measurement of microclimate and ventilation control, and is characterized by high resolution and a wide range of applications. The device has a telescopic probe on the end that enables the measurement in difficult access areas. Air velocity was measured by an anemometer PCE-AM 82. With this instrument there were measured the temperature inside the buildings as a control indicator. Airflow speed is expressed in m/s and temperature in °C. The concentration of stable gas was measured using the IBRID MX6. This instrument is a universal detector of up to 6 different gases in simulative memory data and operating software. Signaling of IBRID MX 6 devices is performed over a loud beep with an accompanying flashing display. The instrument gives a signal to a low or high level. IBRID MX 6 machine has an optional electric pump, which provides that before entering the area, to check the concentration of greenhouse gas emissions that are already in it. The suction pump allows the connection pipe length up to 30 m for intake of air into the instrument and detection of gases. The device has its own memory where data is stored by the given parameters. Before measuring of gases the device was calibrated and values where actually zero values, and values showed in this paper means amounts of gases above normal atmosphere concentration of those. The intensity of light within buildings is measured by the instrument PCE-MLM 1 LUX meter whose measuring range goes

up to 40,000 lux. The resolution of the instrument is 1 lux, and its accuracy ranges from 5% if the luminous intensity of less than 10,000 lux, or in the range of 10% if the luminous intensity is greater than 10,000 lux.

The data obtained by the monitored parameters were processed on the basis of statistical methods and are calculated arithmetic mean, standard deviation, standard error of the arithmetic mean, variation coefficient and the minimum and maximum tolerances.

## RESULTS AND DISCUSSION

Goat farms on which were measured microclimate parameters are belonging to all agro-ecological zones that are represented in Bosnia and Herzegovina. Farms were built of hard materials such as brick and block, to objects made of wood. Table 1 provides data on the size of objects and the number of animals in them.

Table 1. Number of goats and housing surface in visited barns

Category/ statistical indicators	X	S	SX	V	Min. Max.
Goat	112.7	47.96	16,00	42,55	35 180
Capricorn	3.5	2.12	0.80	60,60	1 7
The surface/animal	2.39	1.37	0.45	57,25	0.70 4.31

On all farms goats were kept in the loose housing system. Animal room inside the object are divided into several pens. Number of pens is dependent on the size of the building and the number of goats located in the facility. Depending on the size of the box the number of goats in the same ranged from 5 to 30. The resulting average area per goat is above satisfactory surface ranging from 1.2 to 1.5 m<sup>2</sup> per animal. Larger size of living space than recommended can be explained by the time when they took data from farms. Kidding of goats in our agro ecological conditions begins in early February and ends by the beginning of March, and the measurement of microclimate parameters was performed in the second half of January. Counting that living space which was provided for kid was 0.25 to 0.30 m<sup>2</sup>, we can conclude that the population of goats by objects moving in the normal range.

Table 2. Microclimate indicators inside goat barns

Indicators	X	With	With <sub>x</sub>	V	Min. Max.
microclimate					
Temperature, °C	11,47	2.15	0.71	18,38	6.00 14.00
Temperature of bed of °C	13,00	2.75	0.91	21,16	8.00 17.40
The temperature of the roof, °C	12,01	2.17	0.72	18,04	8.10 14.80
The air flow, m / s	0,039	0.03	0.01	86.65	0.01 0.11
RH of air, %	69.95	13,99	4.67	20,01	58.00 92.00
Light, lux	38.78	48,23	20.38	124.34	0.20 158.00
NH <sub>3</sub> ppm	2.13	0.92	0.35	43,52	1.00 3.00
CO <sub>2</sub> %	0.1	0.02	0.01	22.90	0.08 0.14

The goat breeders of high yielding goats should be aware of the microclimate inside buildings because those goats are sensitive to low temperatures, drafts and moisture. So for these reasons to have healthy and highly productive goats in barns, favorable microclimate conditions must be provided. Table 2 provides information on the microclimate inside visited barns of goats in Bosnia and Herzegovina.

The microclimate parameters are important indicators of air quality in the housing facilities for goats. Inside the facilities it is necessary to provide appropriate microclimate conditions, no whose largely depends the health and welfare of the animals, so as poorly ventilated barns with stale air, are inadequate environment for the skin. In addition microclimate in barns has a big influence on milk production, because any deviation levels of certain microclimate indicators than those recommended could result in reducing milk production. Goat which have below the cool litter, which was served cold food and water, will less time spend lying and resting on the contrary it will stand more, will shiver and waste energy. From these goats breeder will get lower production, they will get sick more often, especially on respiratory organs and udder diseases. Goats that are located in facilities where there is high temperature losses of appetite and food consumption and consequently reduce milk production. As we see, both extremes, low and high temperature inside the facilities has the final outcome of reducing the production and health damage goats. The corresponding temperature is in the range of 5 °C to 27 °C, while the optimum temperature range of 10 °C to 15 °C in the accommodation facilities of adult goats. For kids preferred temperature is slightly higher, and it is moving in the intervals of 12 °C to 27 °C, and optimum in the range from 18 °C to 20 °C within barn (Simović and Kojic, 1981). However a study by Bøe et al. (2007) measuring thyroxine (T4) indicates that goats adapt within 2 days to an ambient air temperature of 128C. Cold, uninsulated housing is commonly used for dairy goats in Canada, Sweden and Norway (Bøe and Ehrlenbruch, 2012). In the housing facilities for goats for whose were determined the microclimate status, the average temperature was in the range of optimal values. Temperature of lying surfaces and the temperature of the roof had higher average value than the temperature inside the building, what has logical explanation. In all the facilities where they lay there were deep litter, which retains heat, besides the warm air is lighter and goes to the roof of objects and the heat same.

Livestock facilities should protect the animals from adverse weather conditions and to provide good health, well-being and productivity of animals. This is possible only if the object is technologically well equipped, functional and has a good structural solutions, which largely determines the microclimate conditions inside buildings (Marciniak, 2014). Already in the design phase of buildings it is to plan appropriate exchange between object and surroundings, which is achieved by designing adequate ventilation. All visited farms used natural ventilation, only one had in addition to natural and artificial ventilation. Ventilation of the building is necessary because in order to make exchange of the polluted indoor air with fresh coming from the outside. Inadequate ventilation can cause adverse health effects on goat, if it manifests as a directed flow, which are directly exposed to the skin. A strong draft can cause negative consequences, especially on the health of goats, and if the intake air have much lower temperature than the temperature of the air that is in the animal room and the goat body. Depending on the breed and categories of animals air velocity should to be limited to 0.2 m/s, and only during the summer, when are higher temperatures this can reach as 0.5 m/s. Average airflow in facilities for goats in Bosnia and Herzegovina was below the 0.2 m/s during the winter period. This air flow was expected, as in the period of investigation the outside temperatures were quite low. Ventilation in the winter, especially when outside temperatures are

low, should be minimal, just to remove the polluted air, while ventilation in the summer should be a maximum with a view to eject excess heat from buildings.

Humidity inside goat barns depends on the humidity of air entering the barn, either natural or artificial ventilation, and humidity that occurs within buildings. Humidity inside buildings may originate from the animals through breathing and evaporation from urine and feces. Relative humidity inside goat barns should range from 40% to 80% (FAO, 1988). High humidity range air in animal housing hinders normal body moisture and heat exchange with the environment, causes diseases of the skin and mucous membranes, appear cold and soiling of the body and on the other hand, low humidity range causes increased amounts of dust floating in the air, which causes dryness and inflammation respiratory mucosa, and by itself causes great loss of moisture by evaporation, and the constant feeling of thirst (Radivojevic, 2005). The average relative humidity in the goat barns in Bosnia and Herzegovina ranged permitted values. Szulc and Rezeznik (2007) reported that high humidity in winter increases the feeling of cold, and in order at the optimal temperature (15 °C) optimal relative humidity was 75%. In addition, the same authors report that high temperatures and low relative humidity causes dry mucous membranes of animals, which makes them vulnerable to infection.

During the day, the interior lighting of the largest number of visited barns achieves natural light. In order to ensure enough daylight, and in addition to ventilation, windows should cover from 8 to 10% of the total floor and wall area. The windows through which one gets the most of daylight are set so that light falls goats on its back, in addition to plans to crib should be well illuminated. At the present time in the intensive system of goat breeding are increasingly practiced by the application of artificial lighting.

The presence of gas in the barn relates to the level of carbon dioxide (CO<sub>2</sub>), ammonia (NH<sub>3</sub>), hydrogen sulfide (H<sub>2</sub>S) and methane (CH<sub>4</sub>) in the barn air. The presence of sulfur-hydrogen and methane in the stable air can be recorded over the limit very rare. In the intensive livestock harmful gases accumulate in the barn air, originating from the same metabolically processes that occur in animals or feedstuffs for goats. Goats secrete themselves breathing gases, as well as gases generated by fermentation and decomposition of organic matter from feed and manure. The fermentation and decomposition of organic matter in stables was particularly emphasized during the summer, when decomposition processes are accelerated under the influence of high temperatures, although the same effects can occur in the winter, when it comes to maintaining a favorable temperature barn air, and when ventilation rate is reduced to a minimum (Radivojevic 2005 ).

Ammonia is a strong irritant gas, odor, is toxic in animal housing, and it is formed by decomposition of feces and urine. Ammonia concentration above the permissible values in the animal room air irritates the mucous membranes of the respiratory tract. The increased concentration of ammonia in facilities may occur due to unclear deposits of feces and bedding straw. Ammonia is much lighter than air, so it is in the upper layer of animal room air (Radivojevic, 2005). The concentration of ammonia in the barns depends on the type of stalls, the number of animals in the house, and on the external factors such as temperature, humidity and air flow. In addition to these factors on the level of ammonia in the buildings affected by additional ventilation, types of mats and frequency of cleaning stalls (Groot Koerkamp et al., 1998; Wathes et al., 1998). Also, wet conditions, it is to increase the relative humidity or humidity of bedding material, increase the rate of generation of

ammonia (Hristov, 2002). The presence of ammonia in the barn air is allowed in concentrations up to 0.15 l / m<sup>3</sup> or 0,015% by volume, or 150 ppm. The average determined concentration of ammonia in the air barn goat farm is located below the allowable limit. That in the buildings was present inadequate ventilation confirms the very low speed of the airflow, which is far below the speed limit for winter conditions of 0.2 m/s.

The concentration of CO<sub>2</sub> in the stables for animals depends on the building structure, the number of animals accommodated, technical characteristics and functionality of the ventilation system. Carbon dioxide is collected at the floor of the object because it has a larger specific weight than air. Due to its solubility in water, occurs when in ceiling area when it is bound to water vapor, which is warmer and lighter than air, so for these reasons is moving toward a ceiling in the barns. In the German Standard (DIN 18910, 1992) carbon dioxide is regarded as an indicator of ventilation intensity in animal housing and a carbon dioxide level of 0.3 % should not be exceeded. However, if add the atmosphere CO<sub>2</sub> to average values of CO<sub>2</sub> measured in visited goat barns, still those were half lower below limit (0,14%).

### CONCLUSION

Goat production in Bosnia and Herzegovina is in a form of expansion for the reason that there are favorable conditions for goat breeding, and goat offers high-quality and high-grade products for human consumption. In addition itself goat production is profitable, perhaps at this moment more profitable than other branches of livestock production. Goat production is based on noble races, balanced diet and adequate housing. Noble breed of goats intended for high milk production are kept in an intensive way in buildings designed in detail for the purpose by technological activities and respect animal welfare. On the base of conducted investigation, seems most of the farmers take care on housing quality of kept animals, however in some barns ventilation systems should be advanced.

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