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MICROCLIMATE PARAMETERS AT DIFFERENT WAYS OF KEEPING FATTENING YOUNG STOCK

ПАРАМЕТРИ МІКРОКЛІМАТУ ЗА РІЗНИХ СПОСОБІВ УТРИМАННЯ ВІДГОДІВЕЛЬНОГО МОЛОДНЯКУ

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The microclimate in the livestock building plays a significant role in the maintenance of farm animals. The data on growing and fattening of young cattle are disclosed in detail, where among the factors that affect beef production are zoohygienic conditions, feeding level and genetic potential of animals. But at the same time, there is not enough information on optimizing the conditions of keeping over repair young Ukrainian black-and-white dairy cattle in the stall period on small farms. Especially needs to be studied the sanitary and hygienic condition of the microclimate in the premises at different systems of keeping young animals. Namely, constant monitoring of the level in the air environment of the premises for fattening young cattle in the stall period: temperature, relative humidity, concentration of carbon dioxide, ammonia and microbial contamination, heat balance and providing standard feeding conditions, which will significantly improve the efficiency of using overhauled young cattle.

Thus, at the age of 14 months for fattening young bulls, it turned out to be promising to keep bulls in group cages without ties in terms of air temperature in the premises is 14.6 ° C. This temperature regime for keeping bulls at the age of 14 months is close to the level of optimal neutrality technology.

In the stall period, when keeping bulls of the Ukrainian black-and-white dairy breed in group cages from 12 to 14 months of age, better conditions for air humidity are created than in tethered housing.

Bulls in group cages were kept with a lower level of air carbon dioxide concentration than bulls on a tether. The difference is significant ($P<0.05$ - $P<0.001$) depending on the time of research, and the time of sampling and age of bulls.

Studies on the concentration of ammonia in different days of specific age periods of bulls of the Ukrainian black-and-white dairy breed and the time of year showed that, regardless of the age of the bulls and the determination of the concentration of ammonia in the air of the premises, less of it accumulates where the bulls were kept untethered.

The search for improvement of microbial contamination after 12 months of age of bulls, regardless of the way they are kept, requires new approaches. Comprehensive assessments of the appropriate number of factors affecting the air environment in bull housing at different ages may be necessary. This is especially important in small farms where optimization of housing conditions is essential.

More heat is received from young stock at this age period (14 months) than at the total cost of 5058 kcal/h or the cost was less by 15 percent. At the same time, the situation changed when young animals were kept in group cages. Thus, more young animals released free thermal energy into the air and more of it was spent on heating the air. Therefore, the heat balance was negative with a difference of 2433 kcal/h or 94.6% to zero balance. But, such excess heat consumption over the supply is included in the established parameters of the norms of technological design of premises for cattle.

Keywords: *microclimate, young cattle, housing, fattening, carbon dioxide, air environment, ammonia concentration, microbial contamination, heat balance.*

According to the recommendations on livestock production technology, beef production should be ensured mainly by intensive rearing of young cattle from the day of birth to 16-18 months of age, as well as by culling adult cattle for meat.

The development and improvement of beef production technologies on an industrial basis, preservation of animal health, creation of optimal conditions of keeping, reduction of the period of growing young cattle to 14-16 months of age is the strategic basis for providing cattle with comfortable living conditions (Kaletnik G.M. et al., 2007; Botvina N.O., 2009).

And among the factors that need attention, first of all, there should be a full feeding, which should be transferred to the current automated lines with minimal labor costs and hygienic conditions of detention (M.V. Zubec, et al., 2005; Shulga L.V., 2015). And among the systems of keeping - tetherless with different methods: on deep unchanged litter, on dense litter or in boxes.

Studies on the comparative study of tethered and untethered keeping of young animals have established that the tethered system of keeping animals has a number of advantages that lead to feed savings. When taking into account sex and age groups, it is possible to better organize feeding depending on the level of meat productivity, to identify individual characteristics of animals. However, compared to free-range housing, it requires more labor costs for production. In a general comparison of tethered and free-stall bulls, the advantage of tethered bulls is only in feed saving, and zoohygienic conditions of tethered bulls are much worse for the development of young animals than free-stall bulls, so the efficiency of beef production is more attractive (M.V.Demchuket al., 2010; Yaremchuk O.S. 2010).

The total cost of feed in free-stall cattle is somewhat higher than the cost of their productivity in case of violations of zoohygienic conditions of cattle keeping on a tether. This issue is debatable, because the conditions of the enterprise are not taken into account (Demchku M.V., 2002; Shust P. 2018).

Livestock production technologies are always accompanied by the restructuring of the productive type of animals, the need for further improvement of livestock breeds and methods of breeding work with them (L.V. Polovij, et al., 2002; Bashenka M., 1999; Starostenko I.S., 1998; Petkova L.O., 2014). In addition, the concentration of production reduces the possibility of an individual approach to animals, their maintenance and use. This caused the need to increase the homogeneity of the livestock not only in terms of productivity, but also in terms of behavior, eating standard diets and keeping in conditions of high concentration of animals and their adaptability to stress factors (Melnichuk M.D., et al., 2008).

Growing and fattening of young cattle by intensive technologies is aimed at the fact that during this period animals are able to eat a large amount of feed (Shablya V.P., Admin O.Ye., Hramcova O.M., 2008). During this period, young animals are fed silage, haylage, hay, green fodder and mixed fodder in the form of complete mixtures or in the form of granules and briquettes. Such feeds can be distributed to young animals in stationary or mobile feeders. The amount of feed and its nutritional value is regulated by the feeding front (width of stalls or combine boxes) (Kulik M.F., Ponomarenko M.M., Dudko M.F., 1991).

The technology of feeding young cattle is one of the technological processes of

providing them with adequate nutrition. Thus, the preparation of a large amount of quality feed for animals is a laborious process (Kalashnikova A.P. et al., 2013). Grinding feed is important because it facilitates the process of preparing feed for feeding. Mechanization of feed distribution requires grinding hay, root and tuber crops and other feeds, which are mostly poorly transportable.

According to the daily routine, there are problems with the order of feeding according to the ration. In most cases, in one feeding the animals receive an excessive amount of feed, and in the second - not enough. This leads to irrational use of feed, and a large set of feed again complicates the uniformity of feeding them during the day. Depending on the natural and economic conditions and the forages available on the farm, the following types of feeding are used for feeding over-repair young stock during the growing and fattening of livestock for meat: silage and pulp, silage and root crop, silage and pulp; in summer - on green forages or on pastures (Pivtorak Ya.I., et al., 2018).

The microclimate in the premises where overhauled young cattle are kept depends on the creation of comfortable conditions for their maintenance. This results in animal health, high productivity and better quality and cost-effective management of the livestock industry (Chuprina O.P., 2002).

Thus, the ethological characteristics of animals did not correspond to free-stall housing. There were problems with the completion of technological groups by types of nervous activity. This leads to the revision of technologies of keeping and feeding animals (Cvigun A.T., et al., 1999). There were designs of special grids that fixed animals near the feeders, which limited the movement of young animals in the group cage during their feeding (Cvigun A.T., et al. 2001). And during the period of puberty, bulls were provided with special equipment for tethered or untethered keeping - electrically stimulating sexual reflexes.

The conditions of keeping animals by many indicators did not always satisfy the biological needs of young cattle. Thus, after the development of production capacities of the enterprise for the production of beef complex, animal diseases arise, productivity decreases, the enterprise loses the achieved indicators of profitability. Industrial technologies very often limit some natural needs of animals. Intensive exploitation of animals leads to stressful situations, increases the sensitivity of animals to deterioration of microclimate, to changes in feeding, to constant regrouping of animals, etc. (Fedoruk R.S., et al., 2002). This is due to the fact that the industrial technology of production processes provides for the cyclicity of processes and constant management of animals (veterinary treatments, weighing, placement in different age periods, etc.), and all this is a prerequisite for the reproduction of microorganisms and the development of stress. Therefore, systematic cleaning of livestock premises and disinfection is mandatory to maintain proper sanitary conditions of the enterprise and reduce the frequency of regrouping of young animals during the period of their maintenance from birth to sale or allocation to separate specially equipped group cages (Admin Ye.I., et al., 2000).

Often animals are not prepared to function under the conditions of industrial technology. There is a complex problem of animal communication with machine technology. For cattle the most progressive way of keeping is untethered. But it is

advisable to continue development to improve the technology of free housing. Thus, they should be mainly aimed at bringing animals closer to natural conditions and creating positive effects on their vital activity (Polovij L.V., et al., 2010).

Thus, in the period of reforming the agricultural sector of Ukraine, questions have arisen that need to be addressed regarding the feasibility of industrialization of small-scale enterprises for the production of milk and beef.

On beef farms, mainly four such tasks are solved:

1. Creation of normal sanitary and hygienic conditions, in which animals can stay the whole stall period without the use of walking grounds.

2. Increasing labor productivity at least 2 times on the basis of scientifically based modern technologies and systems of keeping animals (especially free-range) and related measures for labor organization.

3. Ensuring a balanced and complete feeding of animals in such a way that the feed rations fully meet the needs of the animal body and taking into account the productivity of age and conditions of detention.

4. Rational use of waste to obtain alternative energy sources.

Zoohygienic conditions of keeping animals together with the use of intensive, and even better integrated technologies in the work of fattening enterprises and the use of biologically complete feeds, taking into account the age and condition of animals, can increase the efficiency of livestock production by 10 percent or more.

In the modern conditions of beef cattle breeding from over-repairing young cattle, first of all, it is necessary to create optimal conditions for growing and fattening young cattle, including Ukrainian black-and-white dairy breeds. The issue of providing standardized feeding can, as literature sources show, be successfully implemented in 1 year, and in order to create zoohygienic conditions, in addition to high qualification, funds for reconstruction, it is necessary to have regulatory documents, which are not enough (Zotko M.O., et al., 2011). Therefore, there is a need for urgent scientific research of various systems of keeping suckler cattle on small farms, which will accelerate the implementation of the Presidential Decree "On urgent measures to accelerate the reform of the agricultural sector of the economy".

Thus, it can be seen that the data on growing and fattening young cattle are presented in detail, where among the factors that affect the production of beef are zoohygienic conditions, feeding level and genetic potential of animals. At the same time, there is insufficient information on optimizing the conditions of keeping over repairing young Ukrainian black-and-white dairy cattle in the stall period on small farms. Especially the sanitary and hygienic condition of the microclimate in the premises under different systems of keeping young animals needs to be studied.

The *temperature* of the air environment in the premises for keeping bulls in tethered and free-range housing. The temperature of the air environment can positively or negatively affect the thermoregulation of the animal body. When the air temperature in the cattle house decreases, there is a need for additional feed energy. This increases the cost of feed, and if not compensated, it leads to a decrease in productivity. In production conditions, it is not always possible to make timely adjustments to the rations of animals depending on the parameters of lowering air temperature. Therefore, in the stall period, where the external air environment is

below zero on most days, then the technology of keeping animals indoors and the operation of ventilation systems should provide optimal air temperatures.

In most agricultural enterprises, bulls are kept tethered, and some are kept untethered in group cages. The study of zoohygienic conditions of the air environment in the premises for fattening of overhauled young stock according to the assessment methodology was carried out on two adjacent days (5-6, 15-16, 25-26). The air temperature in the room was determined at 10 and 20 hours in four places. Determination of the air temperature at 10 o'clock compared to 20 o'clock in the premises where bulls were kept tethered and untethered showed that in most cases at 20 o'clock the air temperature was higher by 3.3 oC (tethered) and 3.2 oC (untethered). This can be explained by the fact that the outside air is warmer during the day than at night. Therefore, at night more heat is lost through the building envelope and ventilation system than during the day.

Studies have shown that bulls release heat energy into the air, which as a result increases to 20 hours compared to 10 hours at the age of 12 months. The following parameters of air temperature were established: from 13.7 to 17.2 ° C (tethered housing) at 10 o'clock and from 14.2 to 18.2 ° C (untethered housing), and at 20 o'clock, respectively, from 15.5 to 17.7 ° C and from 15.0 to 18.2 ° C.

Comparing with each other tethered and untethered keeping it is possible to note the following:

- more heat was preserved in the room at 10 and 20 hours, where bulls were kept tethered, and in comparison with untethered, a significant difference was found at $P<0.05$ and $P<0.01$; (number of samples 3; 4)

- more heat was preserved in the room where bulls were kept untethered in group cages (study at 10 hours). The difference is significant at $P<0.05$ (number of samples 5; 6);

Thus, the formation of the temperature regime in the premises for keeping bulls is influenced by the age of the animals, their energy released into the air and the ambient temperature. Under appropriate environmental conditions, the advantage is on the side of tethered housing, and under other conditions - on the side of free-range.

When determining the air temperature at the age of 14 months of bulls, it was found that at the beginning of the month the air temperature in the room was 12.5 °C (tethered) and 13.2 °C (free-range) (at 10 o'clock) and 16.3 ° C and 16.7 °C at 20 o'clock, respectively. At the end of the month, at 10 o'clock, the temperature was 14.5°C and 17.5oC for tethered and at 20 o'clock - 16.2°C and 18.2°C, respectively.

These data show that again the formation of indoor temperature is influenced by the external environment, and only then by the conditions of keeping bulls. But at the same temperature conditions of the environment in the premises where the bulls were kept in group cages, it is possible that more heat was released by the animals and the average air temperature on some days was higher compared to the tethered one at $P<0.005$ and at $P<0.001$.

It was found that there is a tendency of advantage of free-range housing in terms of indoor air temperature in relation to tethered housing and with age this advantage increases.

So, at the age of 14 months for fattening young bulls, the untethered keeping of

bulls in group cages in terms of air temperature in the premises is 14.6 ° C was promising. This temperature regime for keeping bulls at the age of 14 months is close to the level of optimal neutrality technology.

The accumulation of *moisture* in the air of the premises at different ways of keeping bulls in the stall period. Increased air humidity in livestock buildings is a good environment not only for the reproduction of microbes, but also leads to heat loss through the skin of the body of animals.

Most moisture enters the air when it evaporates from the floor, manure grooves, drinkers. Moisture can enter the room, as well as with the outside air, especially at low temperatures.

Therefore, timely removal of moisture from the air is an important hygienic measure. In such premises, due to specially equipped natural ventilation, the moisture in the air of the premises for animals is reduced, which is maintained in the air in the parameters of 50-75%.

In the context of the reconstruction of existing livestock buildings in each case, it is necessary to make technological decisions that can positively affect the normalization of humidity in the air of the animal premises. Assessment of air humidity in the stall period in the premises with different ways of keeping bulls allows to determine the optimal level of moisture accumulation.

Thus, the study of air humidity conducted simultaneously with the determination of other air parameters in the sections for keeping bulls tethered (control) and untethered in group cages of 10 bulls showed that the air was assessed twice a day (at 10 and 20 o'clock in four places of the section and in the center of the group cages at a height of 50 cm from the floor).

It was found that the air humidity at the age of 12 months was in different sections for keeping bulls of Ukrainian black-and-white dairy breed when kept in a group cage of 10 bulls, where the air humidity parameters at 10 o'clock was within 71%, and at tethered - 85%.

The accumulation of high humidity in the air of the premises where the bulls are kept on a tether is felt even without determination by special devices. Thus, about 1/3 of the wooden plank floor constantly accumulates moisture. In addition, in the cracks between the boards there is moisture that evaporates into the air. In some cases, urine and feces fall almost on the entire floor. At the same time, the group cage has clearly defined feeding and resting areas. The use of wood flooring leads to the accumulation of urine under the floor.

Continued studies of air humidity in the premises for keeping bulls at the age of 14 months showed low efficiency of reducing humidity in the air, while observing the norms of technological design of stalls in width and length for bulls of this age do not allow to reduce the accumulation of moisture in the air. Thus, the relative air humidity on all days of research at 10 and 20 hours was higher than 70-89.5%.

In addition to the reasons for the increase in the amount of moisture in the air, which were in tethered housing at 12 and 14 months, the following were added: feeding more feed and watering; excretion of more urine and feces; excretion of more moisture through the skin and lungs, etc. In free-range housing, such changes did not

significantly affect the increase in moisture in the rooms where the bulls were kept.

Thus, it was found that in the stall period, when bulls of Ukrainian black-and-white dairy breed were kept in group cages from 12 to 14 months of age, better conditions for air humidity were created than in tethered housing.

Concentration of carbon dioxide in the air of the premises with tethered and free-range bulls. In livestock buildings carbon dioxide in the optimal amount plays a significant role in the life of animals and is a physiological irritant of respiratory centers. Increasing the concentration of carbon dioxide in the indoor air reduces oxidative processes, lowers body temperature, increases the acidity of tissues and enhances other metabolic processes undesirable for animal health. Increased concentration of carbon dioxide has a negative effect on animals. Their productivity and resistance to diseases decreases.

Therefore, it is important to equip ventilation systems that would provide an optimal level of carbon dioxide. We set the goal to conduct a comparative assessment of the concentration of carbon dioxide in the premises where bulls are kept on a tether and in group cages at different ages (12 and 14 months) and compare it with the permissible concentration of carbon dioxide (0.2%).

The study of *CO_2 concentration* in the air of the premises was carried out simultaneously with the determination of other air parameters when bulls were kept tethered and untethered in group cages of 10 bulls from 12 to 14 months of age.

Assessment of CO_2 concentration was carried out 6 times in four points of the premises at 10 and 20 hours. The concentration of carbon dioxide was determined with 0.005 normal solution of caustic barium.

It was found that at 12 months of age, the concentration of carbon dioxide increased to 0.26-0.32% with tethered keeping, and much less to 0.17-0.23% (at 10 o'clock) with untethered keeping.

Analyzing the concentration of carbon dioxide, it should be noted that at 20 o'clock, its parameters were as follows: with tethered keeping - 0.23-0.26%, with untethered keeping - 0.15-0.22%. On average per day, the concentration of carbon dioxide in the air where bulls were kept in group cages was found to be lower on all days of the study.

At the age of 14 months, the concentration of carbon dioxide in tethered cages was in the range of 0.23-0.31%, and in untethered cages 0.14-0.17% (at 10 o'clock). The difference is significant at $P<0.001$. At 20 o'clock, the parameters of carbon dioxide concentration decreased compared to the estimate at 10 o'clock.

This decrease in the concentration of carbon dioxide from 10 to 20 hours can be explained by the fact that during the day more outside air enters the room, in which the concentration of carbon dioxide is much lower than in the room and ventilation is better. In the room where the bulls are kept in group cages, the concentration of carbon dioxide is lower than in the premises with tethered keeping. Thus, in addition to carbon dioxide exhaled by bulls, more of it is mixed in the air along with the evaporation of moisture from the floor, stalls, feeders, grooves of manure conveyors, technological equipment and enclosing structures.

Thus, it was found that bulls in group cages were kept with a lower level of air carbon dioxide concentration than bulls on a tether. The difference is significant

(P<0.05 - P<0.001) depending on the time of research, and the time of sampling and age of bulls.

Ammonia concentration in the premises during the stall period of Ukrainian black-and-white dairy bulls in tethered and free-range housing. According to the assessment of ammonia concentration in animal premises, the processes of decomposition of nitrogen-containing organic substances: urine, feces, feed, etc. Ammonia dissolves intensively in water. Especially a lot of ammonia accumulates in cold rooms with high humidity. High concentration of ammonia leads to the fact that the animals' health deteriorates, feed is not sufficiently digested, death may occur when the concentration of ammonia in the air increases to 3 mg / l, from pulmonary edema or respiratory paralysis.

Therefore, the search for reducing the concentration of ammonia in the premises for animals is relevant and necessary in the conditions of reconstruction of existing livestock buildings, where the conditions of detention and equipment of ventilation systems do not always allow for minimal accumulation of ammonia in the air.

In this regard, the assessment in different months of the stall period, at different times of sampling, with different methods of keeping, where animals were raised and fed for meat, the level of ammonia concentration in the premises in accordance with the standards is not the same.

Studies of the ammonia concentration in the air of the premises where bulls were kept at the age of 12 months showed that in the free-range bulls the ammonia concentration was respectively lower by 43, 28, 37, 29, 63, 59 percent compared to the tethered one with a significant difference P<0.001. These data show the advantage of untethered bulls over tethered ones.

Perhaps, in addition to the ways of keeping bulls and premises, there are factors that affect the accumulation of ammonia concentration in the air. But the tendency of preference for untethered bulls in group cages remained at 14 months of age. Similar data were obtained when comparing the concentration of ammonia in the air of premises with tethered and untethered methods of keeping bulls at 14 months of age. Again, with a significant difference, a lower accumulation of ammonia in the air was obtained in the room with free-range bulls (P<0.001).

Studies on the concentration of ammonia in different days of specific age periods of bulls of the Ukrainian black-and-white dairy breed and the time of year showed that regardless of the age of bulls and the determination of the concentration of ammonia in the air of the premises, less of it accumulates where the bulls were kept free.

Optimization of the conditions of keeping young cattle in beef production through the use of the proposed modules of group cages for different technological periods leads to the conclusion that the more adapted to fattening of overhauled young cattle on small farms of reformed agricultural enterprises in terms of ammonia concentration in the air of the premises is the keeping of young cattle without tethering.

The fact that the deterioration of the air environment due to the accumulation of ammonia in the tethered keeping of bulls of the Ukrainian black-and-white dairy breed at 12-14 months can lead to a decrease in live weight gain was found in further

studies of the growth rate of experimental bulls.

Total microbial contamination of air in the premises for keeping bulls in tethered and free-range housing. The number of microorganisms in the indoor air is 50-100 and more times higher than in the outdoor air. Microorganisms in the air can be from several tens to hundreds of thousands in one cubic meter. Therefore, among the indicators that are included in the assessment of the microclimate in the premises for animals is the total microbial contamination of the air.

Depending on the *number of microorganisms* in the air, hygienic measures are taken to reduce them. Such measures include regular cleaning of stalls, cages, passages, feeders, equipment, etc. according to the daily schedule.

A special role is played by the amount of moisture and dust in the air of the room in the accumulation of microorganisms. Moisture in the air is a good environment for the development of microorganisms, which in dry and warm rooms practically do not develop and do not multiply, thereby not harming the health of animals. Therefore, in livestock buildings, the task is to constantly reduce moisture through the equipment of automatic waterers, timely removal of urine and feces from the premises and constant operation of the ventilation system.

In our research, we studied the total microbial contamination of the air in tethered and untethered bulls of the Ukrainian red-and-white dairy breed at 12 and 14 months of age.

Studies of total microbial air pollution at 12 months of age have changed the advantages of tetherless housing over tethered housing.

On average, at the age of 12 months, the total microbial contamination of the air in the premises was 1.9, 2.9, 4.1, 2.3, 2.2, 2.8 times lower in the free-stall bulls compared to the tethered ones. The difference is significant at $P<0.001$. The obtained results of air in the premises for keeping bulls at 14 months show that with increasing age, regardless of the method of keeping, the conditions of the air environment deteriorate. Thus, the total microbial contamination of the air in tethered housing was from 48.5 to 152.5 thousand/m3, and in untethered housing - 46.2-91.5 thousand/m3. The difference between the methods of keeping is significant ($P<0.001$).

Beef producers can be convinced that tethered housing of bulls worsens the air environment, where the total microbial contamination of the air is much higher than in free-stall housing.

The search for improvement of microbial contamination after 12 months of age of bulls, regardless of the way they are kept, requires new approaches. Comprehensive assessments of the appropriate number of factors affecting the air environment in bull housing at different ages may be necessary. This is especially important in small farms where optimization of housing conditions is essential.

Heat balance in sections for keeping over-repairing young stock during the stall period. The heat balance in the premises for animals is determined by the normative indicators of air temperature and taking into account the average monthly temperature and humidity in January. In this case, the ratio between the supply and consumption of heat should be equal to zero. A deviation of ±10.0% in the heat balance is allowed. It is known that not only animal productivity, but also hygiene and health depends on the microclimate in livestock buildings. In winter conditions, it is desirable not to

cool animals indoors, as this leads to significant losses in livestock production. During the stall period, the air in the premises is heated by the heat released by the animals. Therefore, air exchange depends on the thermal characteristics of the building envelope. The total area of the section for keeping young animals in different periods with tethered and free-range housing was 345 m^2 or 4.31 m^2 per head, the total area of the outer walls was 162 m^2, 2.02 m^2 per head in both sections and the volume of the room (air volume) was 931.5 m^3. Calculations of the hourly ventilation volume were different both by technology and by the way of keeping young animals. As a result, the volume of ventilation per head was less in tethered housing (fattening 88.0 m^3/h) compared to free-range housing (97.4 m^3/h). The air exchange rate was found to be lower in tethered housing than in free-range housing. Thus, the air exchange rate in the section with tethered housing was 7.4 and 9.3 m^3/h during the fattening period with tethering and without tethering. Thus, with equal characteristics of the premises (sections) for tethered and untethered housing, different indicators were obtained for hourly air volume, ventilation volume and air exchange rate. It depends on the conditions of keeping young stock and the technological period.

Higher rates in untethered keeping of young animals are explained by the fact that in group cages the young animals move more, so they consume more air, which is normalized by the flow of outside air into the room. To determine the heat balance, the data of studying the microclimate in the sections for keeping young animals in group cages and tethered during the stall period were used.

The heat balance in the premises depends on three interrelated factors: the amount of air inhaled and exhaled by animals; the amount of moisture in the air of the premises and the difference in air temperature between the outside and inside. The study of the heat balance in different ways of keeping bulls in the stall period can not be carried out on a small number of groups-analogues, which are sufficient to assess the growth of live weight, slaughter qualities, behavior, etc. Therefore, the experimental bulls are kept together in a room where they were kept tethered and untethered (80 heads each), this number of bulls is enough to fill all the livestock. The table presents data on the heat balance in the sections for keeping overhauled young cattle during the stall period.

Heat loss through the fencing in the section with free-range housing was 9.4% less than in the tethered section, because less moisture enters the air in group cages than in tethered stalls. Due to the smaller area that is constantly moistened with water from drinking bowls, urea and feces. This is confirmed by the fact that 58.1% of the floor is constantly moistened in the group cage: 12.9x7=20.3 m^2; 1.2x5=6.0 m^2; 2x2.9=5.8 m^2; 6+5.8=11.8 m^2 of wetted floor. With tethered maintenance 72% of the floor is wet: 1,8x7=12,6 m^2 (wet floor), 2,5x7=17,5 m^2. Therefore, the absolute humidity of the air was 6.79 g/m3 at tethered keeping, and 6.27 g/m^3 at untethered keeping.

The study of the heat balance in the premises for keeping young animals during the growing period (8-12 months) showed that the heat input from the animals reaches 32448 kcal/h (tethered housing) and 35920 (free-range housing). This heat is spent on heating the air that enters the room (1530 kcal/h), on heat loss through the fence (706 kcal/h), on unforeseen heat losses (81 kcal/h) and heat loss for moisture evaporation

(3213 kcal/h). In total, the heat consumption reached 29922 kcal/h, which is 8.4 percent less than the supply. Therefore, the maximum temperature in the room can be at the tethered keeping of young animals at the age of 12 months in the stall period 15.8 ° C or the difference between the outside and inside temperatures is 15.8 ° C. During the maintenance of overhauled young cattle in the stall period during the untethered period, 35920 kcal / h of heat was received, and the total costs were higher (39933 kcal / h), which reduces the zero heat balance in the room by 10%. Up to 10% increase or decrease of heat balance indicators in relation to zero is allowed.

Feeding of young animals is aimed at making the most of the genetic capabilities of animals at a young age, where, in addition to a high level of feeding, it is important to create standardized conditions for them, especially to maintain a zero balance of heat input and output or deviations of no more than ± 10 ° C. So, at the age of 12-16 months, young animals in the amount of 80 heads at the tethered content of free thermal energy allocated 38696 kcal/hour.

Heat consumption for air heating during tethered keeping reached 2038 kcal/h, for heat loss through the fence - 706 kcal/h, heat consumption for moisture evaporation - 3728 kcal/h. Total heat consumption reached 33638 kcal/h.

More heat is received from young animals in this age period (14 months) than at the total cost of 5058 kcal/h or the cost was less by 15 percent. At the same time, the situation changed when young animals were kept in group cages. Thus, more young animals released free heat energy into the air and more of it was spent on heating the air. Therefore, the heat balance was negative with a difference of 2433 kcal/h or 94.6% to zero balance. But, such excess heat consumption over the supply is included in the established parameters of the norms of technological design of premises for cattle.

The results obtained indicate that with greater movement of animals in group cages, feed energy consumption increased, but thermal heat losses during the stall period allow maintaining the temperature regime during untethered keeping within the established limits for young cattle.

Conclusions:

1. The ecological situation of the cattle breeding site according to the assessment of air, soil and water monitoring is positive and ensures the cultivation of environmentally friendly fodder and the creation of an external environment for animals in accordance with VNTP-APK-01.05.

2. Zoohygienic assessments of the air environment in the premises for keeping bulls for fattening in tethered and free-range housing have shown that more comfortable conditions are created in free-range housing, which is confirmed by a more normalized air temperature compared to tethered from $P<0.05$ to $P<0.001$ (at different times of the day); the accumulation of high moisture in tethered housing is explained by an increase in the area of the wetted floor (1/3 of the parts), and when kept untethered in a group cage, a significant part of the moisture is absorbed by the litter; concentrations of carbon dioxide and ammonia, also, in untethered bulls had a significant positive probable difference from $P<0.05$ to 0.001.

3. Studies of total microbial contamination have shown that regardless of the method of keeping bulls on fattening with age, the conditions of the air environment

deteriorate, where the total microbial contamination of the air at tethered keeping from 12 to 14 months of age was at the level of 48.5 to 152.5 thousand / m^3, and at untethered 46.2 to 91.5 thousand / m^3 (at $P < 0.001$). Therefore, improving the microbial contamination of the air environment in the premises for fattening young animals requires new technological solutions for ventilation systems.

4. It was found that with tethered bulls, the heat balance was positive by 5058 kcal / h or 15%, and with untethered - less by 2433 kcal / h or 94.6% to zero balance, but such a negative heat balance is within the permissible parameters of 5%. But this situation can be corrected by equipping the ventilation system with a heat exchanger.

Literature

1. Botvina, N.O. (2009). Directions of competitiveness of Ukrainian agro-industrial complex on the European food market [Business navigator]. №1. (in Ukrainian).

2. Galanec, V.G. (2010) Signs of revival of competitive agricultural enterprises as a priority form of management [Bulletin of Lviv NAU. Economy of agro-industrial complex] № 17 (2). (in Ukrainian).

3. Pucentejlo, P.R. (2011) Prospects for the development of production potential of beef cattle breeding in Ukraine [Sustainable development of the economy]. №1. (in Ukrainian).

4. Novostavska, A.V. & Svistula, O.V. (2009). World trends in animal development [Scientific Bulletin "Askania Nova"]. №2. (in Ukrainian)

5. Yaremchuk, O.S. Zaharenko, M.O. Kurbatova, I.M. (2010). Environmental and sanitary aspects of monitoring of livestock enterprises [Scientific collection of papers of VNAU]. Vinnicya: Vip.5 (45). (in Ukrainian)

6. Cherven, I.I. & Shebanina, O.V. (2017). The main directions of optimization of production volumes of domestic agricultural products [Bulletin of Agrarian Science of the Black Sea Region]. Vip.2. (in Ukrainian)

7. Barilo, V.M. (2011). Economic efficiency of agricultural production [N Scientific Bulletin of LTSNU and BT named after S.Z. Grzycki]. Lviv: – Tom 13. - №4 (50). Ch.5. (in Ukrainian)

8. Shust, P. & Kebko, V. (2018) Ways to increase beef production with low-cost technology [Proposal]. (in Ukrainian)

9. Petkova, L.O. (2014). Methodological principles of analysis of the use of the potential of the regions of Ukraine for economic growth [Collection of scientific works of Cherkasy State Technological University. Series: Economic science]. Cherkasi: №12. (in Ukrainian)

10. Shulga, L.V. (2015). Energy assessment of technological processes in animals [Scientific works of Poltava State Agrarian Academy. Economic sciences]. Poltava. Tom 3 (22). (in Ukrainian).

11. Burkovskij, I.D. (2007). Efficiency of use of fixed assets in the agrarian sector [Economy of agro-industrial complex]. №4. (in Ukrainian).

12. Baranovskij, D.I. (2010). Our perspective is the technologization of the livestock industry [Collection of scientific works of KhDZVA]. Harkiv, Vip.21. Ch.1. (in Ukrainian).

13. Kaletnik, G.M., Kulik, M.F., Petrichenko, V.F. et al. (2007). The basis of promising technologies of livestock production. Vinnicya: «Enozis», (in Ukrainian).

14. Zubec, M.V., Guzyeva, I.V. et al. (2005). Strategy of beef cattle breeding development in Ukraine in the context of national food security / K.: Agrarna nauka,. (in Ukrainian).

15. Demchuk, M.V. Kozenko, O.V., Knishuk P.V. (2010) To the method of studying the influence of a complex of environmental factors on the functional state of the organism or herd of animals [Scientific Bulletin of Lviv National University of Veterinary Medicine and Biotechnology named after S.Z. Grzyskoho]. Lviv. T.12. №1 (43). Ch.4.- (in Ukrainian).

16. Demchku M.V. (2002) Modern requirements for promising technologies of livestock production [Scientific Bulletin of LDAVM] Lviv.-T.4.(2). (in Ukrainian).

17. Polovij, L.V., Yaremchuk, O.S. (2002). Livestock breeding technologies in reformed agricultural enterprises of Vinnytsia region. Vinnicya: Kniga-Vega,. (in Ukrainian).

18. Bashenka, M. (1999). System of breeding records and genetic evaluation of cattle. Animals of Ukraine. № 3-4 (in Ukrainian).

19. Starostenko I.S. (1998) Comparative evaluation of bulls of different breeds by reproductive traits [Bulletin of BDAU]. Vip.4. Bila Cerkva. (in Ukrainian).

20. Melnichuk, M.D. Novak, N.B., Oblap, R.V. (2008). Features of the genetic structure of Ukrainian black and white cattle [Bulletin of Agrarian Science]. №3.- (in Ukrainian).

21. Kotendzhi G.P. Rubcov I.O. (2005). Productive qualities of newly created breeds and types of cattle in today's conditions. [scientific works of VSAU..] Vinnicya. Vip.22. Ch.1 (in Ukrainian).

22. Chujko N.V. (2006). Increasing the productivity of cattle as a reserve of resource saving increasing the productivity of farm animals: [scientific works of Kharkiv State Veterinary Academy]. T.16. (in Ukrainian).

23. Omelkovich S.P. (2009). Economic and useful traits of Ukrainian black-and-white dairy cows of different genotypes and their correspondence to the parameters of dairy animals. [Scientific works of Kamianets-Podilskyi State Agrarian and Technical University] Kamyanec-Podilskij.Vip.17. (in Ukrainian).

24. Kashenko, M., Sotnichenko, Yu., (2011.) Advanced technologies in dairy farming [Animals of Ukraine] №1-2. (in Ukrainian).

25. Shablya, V.P., Admin, O.Ye., Hramcova, O.M. (2008). State book of breeding animals of cattle of Ukrainian black-and-white dairy breed. K.: PC “Foliant”. (in Ukrainian).

26. Kalashnikov, A.P., Rasinin, V.I., Sheglova, V.V, Klejmenova, N.I. (2003). Norms and rations of feeding of agricultural animals: a reference manual 3e.izd.pererob.i dopovn. (in Ukrainian).

27. Pivtorak Ya.I., Gordijchuk N.M. (2008). High-productive dairy cows and technology of keeping. Farmer.- №3 -4. (in Ukrainian)

28. Chuprina O.P. (2002). Patterns of meat productivity formation in animals of different genotypes of black-and-white cattle in Polissya [Animals of Ukraine]. №3. (in Ukrainian).

29. Cvigun A.T., Povoznikov M.G., Blyusyuk S.M., Melnik Yu.F., Lukash V.P., Zubec M.V., Ibatulin I.I. (1999). Organization of normalized feeding of cattle of beef breeds and types (Recommendations) Kiyiv, (in Ukrainian).

30. Cvigun A.T., Povoznikov M.G., Blyusyuk S.M., Zubec M.V., Bogdanov, Kandiba V.M., Shkurin G.T., Melnik Yu.F., Ibatulin I.I. (2001). [Norms and rations of feeding young cattle of meat breeds and types] Kamyanec-Podilskij: Abetka, (in Ukrainian).

31. Fedoruk, R.S. Tretevich, V.I. (2002). Adaptability of cows of different ages and productivity under conditions of industrial technology of milk production [Physiological journal]. T.48, №2. (in Ukrainian).

32. Admin, Ye.I., Borsh, O.V. (2000). Scientific concept and program of transition of Ukrainian farms to resource and energy saving technologies of milk production [Agrarian news] №2. (in Ukrainian).

33. Polovij, L.V, Romanenko, O.V. (2010). Improvement of technological parameters of tetherless cow housing [Scientific collection of papers of VNAU]-Vinnicya.-Vip.5(46). (in Ukrainian).

34. Polovij L.V., Shevchuk. O.Yu. (2010). Hygienic assessment of the microclimate in calf houses for growing heifers with different technologies of keeping [Scientific collection of papers of VNAU]. Vinnicya, Vip.5 (45). (in Ukrainian).

35. Yasevin S.Ye., (2010). Technology of milk production under conditions of tetherless cow keeping [Zootechnical science of Podillya: history, problems, prospects] Kam'yanec-Podilskij: PP Zvolejko D.G. (in Ukrainian).

36. Zotko, M.O., Gucol, N.V, Vishnevskij, L.V. (2011). Reproduction of cattle in Vinnytsia region [Collection of scientific works of VNAU.] Vinnicya Vip.8 (48). (in Ukrainian).

Анотація. *Мікроклімат у тваринницькому приміщенні відіграє неабияку роль в утриманні сільськогосподарських тварин. Детально розкриті дані по вирощуванню та відгодівлі молодняку великої рогатої худоби, де серед чинників, які впливають на виробництво яловичини, є зоогігієнічні умови, рівень годівлі та генетичні задатки тварин. Але разом з тим, недостатньо інформації по оптимізації умов утримання над ремонтного молодняку української чорно-рябої молочної породив стійловий період на малих фермах. Особливо потребує вивчення санітарно-гігієнічний стан мікроклімату в приміщеннях при різних системах утримання молодняку. А саме постійний контроль за рівнем у повітряному середовищі приміщень для відгодівлі молодняку великої рогатої худоби у стійловий період: температури, відносної вологи, концентрації вуглекислого газу, аміаку та мікробну забрудненість, теплового балансу та забезпечування нормативними умовами годівлі, що дозволить суттєво покращити ефективність використання надремонтного молодняку.*

Так, у 14-міясчному віці для відгодівлі молодняку перспективним виявилось безприв'язне утримання бичків у групових клітках за показниками температури повітряного середовища у приміщеннях складає 14,6ºС. Такий температурний режим для утримання бичків у 14місячному віці наближений до рівня оптимальної технології нейтральності.

У стійловий період при утриманні бичків української чорно–рябої молочної породи в групових клітках від 12 до 14–місячного віку створені кращі умови щодо вологості повітря ніж при прив'язному утриманні.

Бичків у групових клітках утримували з меншим рівнем концентрації вуглекислого газу повітря, ніж бичків на прив'язі. Різниця вірогідна (P<0,05 – P<0,001) у залежності від часу

досліджень, і часу взяття проб та віку бичків.

Проведені дослідження за концентрацією аміаку в різні дні конкретних вікових періодів бичків української чорно–рябої молочної породи та пори року показали, що незалежно від віку бичків та визначення концентрації аміаку в повітрі приміщень менше його накопичується там, де бички утримувались безприв'язно.

Пошуки покращення мікробної забрудненості після 12–місячного віку бичків незалежно від способу їх утримання потребують нових підходів. Можливо, необхідними комплексні оцінки відповідної кількості факторів, які впливають на стан повітряного середовища в приміщеннях для бичків у різні вікові періоди. Особливо це важливо в умовах невеликих ферм, де оптимізація умов утримання має суттєве значення.

Більше надходить тепла від молодняку в даному віковому періоді (14 місяців) ніж при загальних витратах на 5058 ккал/год або витрат було менше на 15 відсотків. У той же час при безприв'язному утриманні молодняку в групових клітках ситуація змінилась. Так, більше молодняк виділив вільної теплової енергії в повітря і більше його було витрачено на обігрів повітря. Тому, тепловий баланс був негативним з різницею 2433 ккал/год або 94,6% до нульового балансу. Але, такі перевитрати тепла над надходженням входять у встановлені параметри норм технологічного проектування приміщень для великої рогатої худоби.

Ключові слова: *мікроклімат, молодняк, утримання, відгодівля, вуглекислий газ, повітряне середовище, концентрація аміаку, мікробна забрудненість, тепловий баланс*

CONTENTS

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