DOI: 10.32636/01308521.2023-(74)-1-13
UDC 636.612.082
V. D. FEDAK, M. I. POLULIKH, O. I. STADNYTSKA,
candidates of agricultural sciences
H. V. ILNYTSKA, researcher
Institute of Agriculture of Carpathian Region NAAS
Hrushevskoho street, 5, v. Obroshyne, Lviv district, Lviv region, 81115, e-mail: vasylfedak55@gmail.com

PULMONARY GAS EXCHANGE IN HEIFERS AND MILK PRODUCTIVITY OF FIRSTBORN COWS OF THE SIMENTAL BREED OF THE PRECARPATHIANS OF DIFFERENT CONSTITUTION TYPES

The results of research on pulmonary gas exchange in heifers and milk productivity of Simmental firstborn cows of Precarpathians of different types of constitution, which were evaluated according to the physiological and selection index developed by us, are presented. The control group included heifers and firstborn cows with a low physiological and selection index – a narrow-bodied type, and the experimental group, respectively – with a high physiological and selection index, wide-bodied type. In terms of depth of breathing, pulmonary ventilation, oxygen consumption, carbon dioxide excretion, total energy and heat production, individuals of the broad-bodied type in postnatal ontogeny significantly outnumbered their narrow-bodied counterparts.

The research results show that the yield of milk per lactation in the first-born cows of the experimental group was higher than that of the control counterparts by 18.29 %. The content of fat and protein in the milk of the cows of the experimental group was higher, compared to the control analogues. Ultimately, the output of milk fat and protein in the first-born cows of the experimental group was also higher than in the control counterparts. Thus, first-born cows of the Precarpathians Simmental breed of the wide-bodied type had a higher index of quantitative and qualitative components of milk than their counterparts of the narrow-bodied type.

According to indicators of gas-energy exchange in postnatal ontogeny, wide-bodied animals (experimental group) significantly outnumber narrow-bodied counterparts (control group). This indicates that the animals of the experimental group have a much more intensive metabolism than the control counterparts. The indicators of milk productivity in the cows of the experimental group were higher than those of the counterparts of the control group.

According to the main indicators of pulmonary gas exchange and milk productivity, animals of the wide-bodied type prevailed over their narrow-bodied counterparts by 10–12 %. Pulmonary ventilation, oxygen consumption and carbon dioxide excretion, the amount of energy in animals of the wide-bodied type was higher by 11–13 % compared to the animals of the narrow-bodied type. Milk

© Fedak V. D., Polulikh M. I.,
Stadnytska O. I., Ilnytska H. V. 2023

productivity in first-born cows of the wide-bodied type was 18.29 % higher compared to the analogues of the narrow-bodied type.

Keywords: heifers, simmental breed, pulmonary gas exchange, milk productivity, milk quality indices, constitution.

Федак В. Д., Полуліх М. І., Стадницька О. І., Ільницька Г. В.
Інститут сільського господарства Карпатського регіону НААН

Легеневий газообмін у телиць і молочна продуктивність первісток симентальської породи Прикарпаття різних типів конституції

Наведено результати досліджень щодо легеневого газообміну у телиць і молочної продуктивності первісток симентальської породи Прикарпаття різних типів конституції, який оцінювали за розробленим нами фізіолого-селекційним індексом. У контрольну групу ввійшли телиці та первістки з низьким фізіолого-селекційним індексом – вузькотілий тип, а в дослідну – відповідно з високим, широкотілий тип. За глибиною дихання, легеневою вентиляцією, споживанням кисню, виділенням вуглекислоти, загальною енергією і теплопродукцією особини широкотілого типу в постнатальному онтогенезі значно переважали аналогів вузькотілого.

Результати досліджень показують, що надій молока за лактацію у первісток дослідної групи був вищий, ніж у контрольних аналогів на 18,29 %. Вміст жиру та білка в молоці корів дослідної групи був вищим порівняно з контрольними аналогами. У кінцевому підсумку вихід молочного жиру та білка в первісток дослідної групи був також вищим, ніж у контрольних аналогів. Таким чином, первістки симентальської породи Прикарпаття широкотілого типу мали вищий показник кількісних і якісних складників молока, ніж аналоги вузькотілого типу.

За показниками газоенергетичного обміну в постнатальному онтогенезі тварини широкотілого типу (дослідна група) значно переважають аналогів вузькотілого (контрольна група). Це свідчить про те, що у тварин дослідної групи обмін речовин протікає набагато інтенсивніше, ніж у контрольних аналогів. Показники молочної продуктивності у корів дослідної групи були вищими, ніж у аналогів контрольної групи.

За основними показниками легеневого газообміну та молочною продуктивністю тварини широкотілого типу переважали аналогів вузькотілого на 10–12 %. Легенева вентиляція, споживання кисню та виділення вуглекислоти, кількість енергії у тварин широкотілого типу була вищою на 11–13 % порівняно з тваринами вузькотілого типу. Молочна продуктивність у корів-первісток широкотілого типу була більшою на 18,29 % порівняно з аналогами вузькотілого типу.

Ключові слова: телиці, симентальська порода, легеневий газоообмін, молочна продуктивність, якісні показники молока, конституція.

Introduction. It is known that the development of animals is based on complex processes of assimilation and oxidation of nutrients in the body. The intensity of growth in different age periods is not the same and the level of metabolic processes in the body of animals is also different. In the

process of development, the level of metabolic processes in the animal body is influenced by the external environment along with hereditary factors. The intensity of complex metabolic processes in the animal body can be judged by the level of gas-energy exchange, which is an integral indicator of complex biochemical and physiological processes in the body.

The studies of many scientists have shown that the basis of animal development is complex processes of assimilation and oxidation of nutrients. Pulmonary gas exchange of animals largely depends on their age, physiological state, feeding conditions and environmental factors [1–14].

The level of gas energy exchange, which is an integral indicator of complex biochemical and physiological processes, indicates the intensity of complex metabolic processes in the animal body [16–30].

In our research, the task was to study the pulmonary gas exchange of heifers and the milk productivity of Simmental cows of different constitution types from the age of six months until the end of the first lactation. Experimental studies were conducted on animals of the wide-bodied type (experimental group) and narrow-bodied (control group) [15].

Materials and methods. The experimental part of the work was carried out in one of the farms of the Drohobytskyi district of the Lviv region. In all experimental animals at the age of 6 months, the activity of aminotransferases (ALT and AST) in blood serum was determined according to the method of A. E. Brausnshtein [2], which made it possible to evaluate the type of their constitution and select them according to the physiological and selection index and form groups to conduct an experiment. The control group included individuals with a low physiological-selection index (105 units) narrow-bodied type, and the experimental group, respectively, with a high physiological-selection index (125 units) wide-bodied type [15]. Assessment of wide-bodied and narrow-bodied types was carried out on the basis of the definition of the broad-bodied index. The control and experimental groups included 10 animals each. Animals with a thoracic index of 60 and above were classified as wide-bodied, and individuals with a thoracic index of 59 and below were classified as narrow-bodied. Pulmonary gas exchange was performed according to the methodical instructions of A. A. Kudriavtsev [7]. Biometric processing of the research results was carried out according to the methodological instructions of S. N. Lopach and others [8].

Results and discussion. **Growth of live weight and linear development of experimental animals**. Live weight is one of the integral indicators that characterizes the body of an animal both externally and internally. In these studies, the task was to study the growth of live weight and the linear development of heifers and cows of different types of

constitution of the Western Ukrainian population of the black and spotted breed from birth to the end of the third lactation.

Table 1 shows that according to the live weight of newborns, at 3, 6, 12, 18 and 21 months, heifers of the experimental group exceeded the control analogues respectively by 1.3; 0.3; 7.5; 8.5; 5.7 and 2.8 %.

1. Dynamics of live weight of Ukrainian black-spotted heifers of dairy breed, kg

Age, months	Groups, M ± m	
	control (n=10)	experimental (n=10)
Newborns	28,9±0,67	29,3±0,45
3	104,5±3,46	104,8±2,93
6	169,2±4,48	181,9±3,68****
12	288,4±5,92	313,0±4,09****
18	375,3±9,23	396,7±7,82**
21	429,2±8,85	441,5±9,71

Note: in this and the following tables * P<0.05; **P<0.01; *** P<0.991.

It should be noted that the live weight of heifers of the control group was at the level of the breed standard at 18 months, and the counterparts of the experimental group in this age period exceeded the breed standard by 5.79 %.

Inspiratory capacity and pulmonary ventilation. During the development of young animals, pulmonary breathing is characterized by the frequency and depth of breathing, as well as pulmonary ventilation. With age, the indicators of pulmonary respiration in animals have a corresponding pattern.

The characteristics of the breathing rate of experimental animals are shown in Table 2.

2. Frequency of air inhalation per minute by Simmental heifers

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	26,9±0,03	25,5±0,79	-1,4
12	21,8±0,47	19,8±0,87*	-2,0
18	20,7±0,50	17,8±1,44	-2,9

Heifers of the control group at 6, 12, 18 months outnumbered the experimental counterparts respectively by 5.49; 10.10; 13.21 %. Thus, the frequency of breathing in the animals in the postnatal ontogeny of the experimental group was lower than that of the control counterparts. With age, the breathing rate decreased in animals of both groups.

If the breathing frequency of the animals of the experimental group was lower than that of the control group, on the contrary, according to the index of the depth of breathing, they significantly prevailed over the control counterparts (Table 3).

3. Depth of air inhalation by Simmental heifers, ml

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	1276±34,12	1575±41,60***	+299
12	2114±34,12	2638±185,30**	+524
18	3012±77,88	3695±319,57*	+683

Heifers at age periods of 6, 12, 18 months of the experimental group prevailed over the control analogues in terms of breathing depth, respectively, by 23.43; 22.68; 22.67 %. With age, the depth of breathing in animals of both groups increased.

According to the indicators of pulmonary ventilation in all age periods, the animals of the experimental group significantly outnumbered the control animals of the same age (Table 4).

4. Pulmonary ventilation of Simmental heifers, l/min

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	34,30±0,87	39,80±0,43***	+5,50
12	48,11±0,70	51,57±0,98**	+3,46
18	62,20±0,15	64,70±1,30	+2,50

The heifers of the experimental group in the age periods of 6, 12, 18 months were superior to the control analogues by 16.03, respectively, according to the indicators of pulmonary ventilation; 7.19; 9.57 %. In the postnatal ontogeny, pulmonary ventilation in heifers of the control and experimental groups increased.

Thus, in terms of depth of breathing and pulmonary ventilation, animals of the wide-bodied type (experimental group) significantly outnumbered their counterparts of the narrow-bodied type (control group).

Gas-energy exchange in animals. The intensity of oxidation-reduction processes in the animal's body depends on the level of digestion and assimilation of nutrients supplied with feed. The level of oxygen consumption during development largely characterizes the intensity of exchange processes in the animal body. Important indicators of gas exchange are the consumption of oxygen and the release of carbon dioxide

by the body in absolute and relative units. The level of oxygen consumption by Simmental heifers is shown in Tables 5 and 6.

5. Absolute oxygen consumption by Simmental heifers, l/min

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	1,01±0,007	1,08±0,02***	+0,07
12	1,41±0,07	1,54±0,02*	+0,13
18	1,71±0,02	1,75±0,01	+0,04

6. Relative oxygen consumption by Simmental heifers, l^{-3}/min/kg

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	6,02±0,16	6,32±0,24	+0,30
12	5,12±0,08	5,12±0,16	0
18	4,41±0,31	4,83±0,11	+0,42

In terms of absolute oxygen consumption, experimental heifers in the age periods of 6, 12, and 18 months exceeded the control analogues respectively by 9.22; 2.34; 20.69 %. Absolute oxygen consumption in both groups increased with age.

A similar pattern was observed in the relative oxygen consumption of experimental animals. Postnatally, the relative oxygen consumption of heifers in both groups decreased.

Thus, in terms of absolute and relative oxygen consumption in the postnatal ontogeny, the animals of the experimental group probably exceeded the control counterparts.

According to the absolute indicators of carbon dioxide excretion, the heifers of the experimental group in the age periods of 6, 12, 18 months exceeded the control analogues respectively by 15.28; 7.20; 14.65 % (Table 7).

7. Absolute release of carbon dioxide by Simmental heifers, l/min

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	0,72±0,09	0,83±0,02	+0,11
12	1,09±0,03	1,14±0,02	+0,05
18	1,11±0,01	1,15±0,04	+0,04

In terms of age, the absolute excretion of carbon dioxide by heifers in the control and experimental groups increased.

The animals of the experimental group also outperformed the control peers in terms of relative carbon dioxide excretion. So at 6, 12 and 18 months, heifers of the research group outnumbered the control analogues respectively by 11.37; 9.88; 7.41% (Table 8).

With age, the relative excretion of carbon dioxide by heifers in both groups decreased.

8. Relative excretion of carbon dioxide by Simmental heifers, l^{-3}/min/kg

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	4,31±0,22	4,80±0,19	+0,49
12	3,80±0,16	3,82±0,12	+0,02
18	3,39±0,12	3,70±0,10**	+0,31

Therefore, in terms of absolute and relative release of carbon dioxide in the postnatal ontogeny, animals of the wide-bodied type (experimental group) probably prevailed over their counterparts of the narrow-bodied type (control group). This indicates that the level of oxidation-reduction processes in the body of the animals of the experimental group was more intense than that of the control counterparts.

The respiratory rate of experimental animals is shown in Table 9.

There was no significant difference in respiratory rate between the animals of the experimental and control groups. In heifers at the age of 6, 12, 18 months, the respiratory coefficient was within 0.71–0.80. In this range, experimental animals undergo fat metabolism.

9. Respiratory rate of Simmental heifers

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	0,71±0,02	0,76±0,006	+0,05
12	0,75±0,05	0,74±0,01	-0,01
18	0,74±0,007	0,77±0,005	+0,03

Energy exchange in the body of animals in postnatal ontogenesis is characterized by the total energy released by animals and the relative accumulation of heat production (tables 10, 11).

According to the absolute release of energy, experimental heifers in the age periods of 6, 12, 18 months exceeded the control analogues respectively by 3.78; 3.61; 4.11%.

10. Total energy released by Simmental heifers, kJ/h

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	1187,8±55,51	1295,1±22,15*	+107,3
12	1726,2±30,25	1791,4±29,34	+65,2
18	2024,2±28,73	2097,3±17,73*	+73,1

In the postnatal ontogeny, the total energy of the heifers of both groups increased. This indicates that with the increase in body weight, the total energy also increased.

The heifers of the experimental group exceeded the control heifers by 9.40, in terms of relative indicators of heat production in the age periods of 6, 12, and 18 months – respectively by 7.55 and 5.18 % (Table 11).

11. Relative indicators of heat production in Simmental heifers, kJ/h/kg

Age, months	Groups (M±m)		± to control
	control (n=10)	experimental (n=10)	
6	7,11±0,22	7,55±0,29	+0,44
12	6,09±0,21	6,18±0,21	+0,09
18 (before insemination)	5,46±0,15	5,78±0,14	+0,32

In terms of age, the relative indicators of heat production in heifers of the control and experimental groups decreased.

Thus, in terms of gas-energy exchange in postnatal ontogeny, wide-bodied heifers (experimental group) significantly outnumbered narrow-bodied counterparts (control group). This testifies to the fact that the metabolic processes in the animals of the experimental group were much more intense than in the control counterparts.

We also analyzed the milk productivity of first-born cows of Simmental breed of milk-meat productivity in the conditions of Precarpathians. The analysis showed that firstborns of the wide-bodied type had higher milk productivity than their narrow-bodied counterparts. Milk productivity and quality indicators of milk are shown in Table 12.

The research results show (Table 12) that the yield of milk per lactation in the first-born cows of the research group was higher than in the control counterparts by 18.29%. The content of fat and protein in the milk of the cows of the experimental group was higher, compared to the control analogues. Ultimately, the yield of milk fat and protein in the first-born cows of the experimental group was also higher than in the control counterparts. Thus, first-borns of the cows of Precarpathians Simmental breed of broad-bodied type had a higher index of quantitative and

qualitative components of milk than their narrow-bodied counterparts. We established a direct relationship between the pulmonary gas exchange of heifers and milk productivity in firstborn cows.

12. Milk productivity of first-born cows of Simmental cattle (M±m)

Indicators	Group	
	control (n=10)	experimental (n=10)
Yield, kg	3100±81,0	3567±170,0**
Fat content, %	3,88±0,044	4,01±0,035**
Amount of milk fat, kg	120,28±12,35	143,31±12,35
Protein content, %	3,34±0,025	3,36±0,041
Amount of milk protein, kg	103,54±6,11	119,85±3,45**

Conclusions. According to indicators of body weight and pulmonary gas exchange in the postnatal ontogeny, wide-bodied animals (experimental group) significantly outnumbered their narrow-bodied counterparts (control group) by 9–11%. This indicates that the metabolism of animals in the experimental group was much more intensive than that of the control counterparts. The indicators of milk productivity in the cows of the experimental group were higher than those of the counterparts of the control group. A direct relationship between the pulmonary gas exchange of heifers and the milk productivity of firstborn cows was established.

Список використаної літератури

1. Бащенко М. І., Хмельничий Л. М. Особливості екстер'єрного типу корів-первісток молочних порід. *Науковий вісник ЛНАВМ імені С. З. Ґжицького.* 2015. № 2, Ч. 3. С. 16–21.

2. Браунштейн А. Е. Переаминирование и интегрирующее значение дикарбоновых кислот в обмене веществ. *Успехи современной биохимии.* 1947. Т. 1. С. 435–455.

3. Голуб О. М., Шаловило С. Г. Визначення виробничих типів корів молочних і комбінованих порід. *Науковий вісник ЛНАВМ імені С. З. Ґжицького.* 2013. Т. 15, № 1 (55), Ч. 2. С. 36–40.

4. Кавка Р. П. Газоенергетичний обмін у бугайців під впливом згодовування тваринного жиру. *Фізіологія і біохімія с.-г. тварин*. 1975. Вип. 27. С. 38–39.

5. Кавка Р. П. Легеневий газообмін і теплопродукція у телиць, вирощених за різного рівня годівлі. *Вісник с.-г. науки*.

References

1. Bashchenko M. I., Khmelnychyi L. M. Features of the exterior type of dairy cows of milk breed. *Naukovyi visnyk LNAVM imeni S. Z. Gzhytskoho*. 2015. No 2, Part 3. P. 16–21.

2. Braunstein A. E. The transamination and integrating value of dicarboxylic acids in metabolism. *Uspehi sovremennoj biohimii*. 1947. Vol. 1. P. 435–455.

3. Holub O. M., Shalovylo S. H. Determination of production types of dairy cows of combined breeds. *Naukovyi visnyk LNAVM imeni S. Z. Gzhytskoho*. 2013. Vol. 15, No. 1 (55), Part 2. P. 36–40.

4. Kavka R. P. Gas-energy metabolism in bulls under the influence of feeding animal fat. *Fiziolohiia i biokhimiia s.-h. tvaryn*. 1975. Issue 27. P. 38–39.

5. Kavka R. P. Pulmonary gas exchange and heat production in heifers reared at different feeding levels. *Visnyk s.-h. nauky*. 1968. No 7. P. 104–106.

1968. № 7. С. 104–106.

6. Когут М. І., Федак В. Д. Розвиток телиць різних ліній симентальської породи. *Передгірне та гірське землеробство і тваринництво*. 2016. Вип. 60. С. 176–179.

7. Кудрявцев А. А. Сравнительные данные по газовому, энергетическому обмену и влаговыделению у животных. *Теплопродукция в организме.* Киев : Изд-во АН СССР, 1964. С. 116–118.

8. Лопач С. Н., Чубенко А. В., Бабич П. Н. Використання статистичних методів у медичних і біологічних дослідженнях. Київ, 2014. 441 с.

9. Мамчак І. В. Легеневий газообмін у помісних бичків залежно від типу годівлі. *Передгірне та гірське землеробство і тваринництво*. 1975. Вип. 20. С. 40–44.

10. Особливості легеневого дихання та енергетичних процесів у корів симентальської породи / В. Г. Грибан та ін. *Вісник Дніпропетровського державного аграрного університету*. 2004. № 2. С. 110–112.

11. Прозора К. Й. Легеневий газообмін у корів різних родинних груп. *Передгірне та гірське землеробство і тваринництво*. 1970. Вип. 8. С. 41–45.

12. Стояновський С. В., Горбаченко М. Г., Федак Н. М. Вікові і міжпородні зміни легеневого газообміну у телиць при інтенсивному вирощуванні. *Передгірне та гірське землеробство і тваринництво*. 1991. Вип. 36. С. 63–65.

13. Стояновський С. В., Цоколаєва Ф. Т. Легеневий газообмін і енергетичні витрати у ремонтних телиць, що вирощуються в спеціалізованих господарствах. *Вісник с.-г. науки*. 1979. № 3. С. 38–41.

14. Федорович Є. І. Біологічні особливості тварин чорно-рябої худоби різної селекції Західного регіону. *Розведення і генетика тварин.* 2000. Вип. 33. С. 157–161.

15. Федак В. Д. Методика комплексної оцінки типу конституції великої рогатої худоби. *Вісник Сумського національного аграрного університету*. Матеріали Міжнар. наук.-практ. конф. *“Перспективи розвитку скотарства у третьому тисячолітті”,* Суми, 2–5 жовт. 2001.

6. Kohut M. I., Fedak V. D. Development of heifers of different lines of the Simmental breed. *Peredhirne ta hirske zemlerobstvo i tvarynnytstvo*. 2016. Issue 60. P. 176–179.

7. Kudriavtsev A. A. Comparative data on gas, energy metabolism and moisture excretion in animals. *Teploprodukcija v organizme*. Kiev : Publishing House of the USSR Academy of Sciences, 1964. P. 116–118.

8. Lopach S. N., Chubenko A. V., Babych P. N. Use of statistical methods in medical and biological research. Kyiv, 2014. 441 p.

9. Mamchak I. V. Pulmonary gas exchange in local steers, depending on the type of feeding. *Peredhirne ta hirske zemlerobstvo i tvarynnytstvo*. 1975. Issue 20. P. 40–44.

10. Features of pulmonary respiration and energy processes in Simmental cows / V. H. Hryban et al. *Visnyk Dnipropetrovskoho derzhavnoho ahrarnoho universytetu*. 2004. No 2. P. 110–112.

11. Prozora K. Y. Pulmonary gas exchange in cows of different family groups. *Peredhirne ta hirske zemlerobstvo i tvarynnytstvo*. 1970. Issue 8. P. 41–45.

12. Stoianovskyi S. V., Horbachenko M. H., Fedak N. M. Age and intergenerational changes of pulmonary gas exchange in heifers during intensive cultivation. *Peredhirne ta hirske zemlerobstvo i tvarynnytstvo*. 1991. Issue 36. P. 63–65.

13. Stoianovskyi S. V., Tsokolaieva F. T. Pulmonary gas exchange and energy costs in repair heifers grown in specialized farms. *Visnyk s.-h. nauky*. 1979. No 3. P. 38–41.

14. Fedorovych Ye. I. Biological features of animals of black and white cattle of different breeding of the western region. *Rozvedennia i henetyka tvaryn*. 2000. Issue 33. P. 157–161.

15. Fedak V. D. Methods of complex evaluation of the type of constitution of cattle. *Visnyk Sumskoho natsionalnoho ahrarnoho universytetu.* Materialy Mizhnar. nauk.-prakt. konf. *“Perspektyvy rozvytku skotarstva u tretomu tysiacholitti”,* Sumy, October 2–5, 2001. Special issue. P. 178–

Спец. випуск. С. 178–181.

16. Associations of various physical and blood analysis variables with experimentally induced *M. bovis* pneumonia in calves / B. Fraser et al. *Am. J. Vet. Res*. 2014. V. 75. P. 200–207.

17. Blasiuk S., Povoznikov M. Impact of energy supply level and the conditions of keeping on the productivity of bull-calves of Aberdeen-Angus breed. *Collection of scientific works of PDATU*. 2000. Vol. 8. P. 214–216.

18. Impact of inflammation on cattle growth and carcass merit / C. Gifford et al. *Anim. Sci*. 2012. V. 90. P. 1438–1451.

19. Haematological and biochemical alterations in calves following infection with *P. multocida* / F. Abdullah et al. *Asian J. Anim. Vet. Adv*. 2013. V. 8. P. 806–813.

20. Haematological and blood biochemical alterations associated with respiratory disease in calves / H. Šoltésová et al. *Acta Vet. Brno.* 2015. V. 84. P. 249–256.

21. Kolisnyk O. Economic efficiency of growing calves of different genotypes of the Aberdeen-Angus breed in the conditions of eastern Ukraine. *Present problems of agricultural production and their solutions* : Materials of International Scientific and Practical Conference. Kharkiv, 2008. P. 72.

22. Kulchytska A. Pulmonary gas exhance of bull-calves and heifers of ukrainian black-speckled dairy breed at different ages. *Animal husbandry of Ukraine*. 2016. No 9. C. 26–29.

23. Mamchur L. Assessment of the current state of meat production in Ukraine. *Economy of Agro-industrial complex*. 2008. No 12. P. 55–58.

24. Nagy O. The effect of respiratory diseases on serum lactate dehydrogenase and its isoenzyme patterns in calves / O. Nagy et al. *Polish J. Vet. Sci*. 2013. V. 16. P. 211–218.

25. Putsenteylo P. Prospects for production potential of beef cattle of Ukraine. *Sustainable economic development*. 2011. No 1. P. 9–17.

26. Ragbetli C., Ceylan E., Tanritanir P. The effect of tulathromycin treatment on biochemical parameters in calves with pneumonia. *Asian J. Anim. Vet. Adv*. 2010. V. 5. P. 169–174.

27. Romanenko T., Bevz A. Modern

181.

16. Associations of various physical and blood analysis variables with experimentally induced M. *bovis* pneumonia in calves / B. Fraser et al. *Am. J. Vet. Res*. 2014. Vol. 75. P. 200–207.

17. Blasiuk S., Povoznikov M. Impact of energy supply level and the conditions of keeping on the productivity of bull-calves of Aberdeen-Angus breed. *Collection of scientific works of PDATU*. 2000. Vol. 8. P. 214–216.

18. Impact of inflammation on cattle growth and carcass merit / C. Gifford et al. *Anim. Sci*. 2012. Vol. 90. P. 1438–1451.

19. Haematological and biochemical alterations in calves following infection with *P. multocida* / F. Abdullah et al. *Asian J. Anim. Vet. Adv*. 2013. Vol. 8. P. 806–813.

20. Haematological and blood biochemical alterations associated with respiratory disease in calves / H. Šoltésová et al. *Acta Vet. Brno.* 2015. Vol. 84. P. 249–256.

21. Kolisnyk O. Economic efficiency of growing calves of different genotypes of the Aberdeen-Angus breed in the conditions of eastern Ukraine. *Present problems of agricultural production and their solutions* : Materials of International Scientific and Practical Conference. Kharkiv, 2008. P. 72.

22. Kulchytska A. Pulmonary gas exhance of bull-calves and heifers of ukrainian black-speckled dairy breed at different ages. *Animal husbandry of Ukraine*. 2016. No 9. C. 26–29.

23. Mamchur L. Assessment of the current state of meat production in Ukraine. *Economy of Agro-industrial complex*. 2008. No 12. P. 55–58.

24. Nagy O. The effect of respiratory diseases on serum lactate dehydrogenase and its isoenzyme patterns in calves / O. Nagy et al. *Polish J. Vet. Sci*. 2013. Vol. 16. P. 211–218.

25. Putsenteylo P. Prospects for production potential of beef cattle of Ukraine. *Sustainable economic development*. 2011. No 1. P. 9–17.

26. Ragbetli C., Ceylan E., Tanritanir P. The effect of tulathromycin treatment on biochemical parameters in calves with pneumonia. *Asian J. Anim. Vet. Adv*. 2010.

technology for the solution of livestock buildings reconstruction using the rules of design of beef production enterprises. *Collection of scientific works of VNAU*. 2011. Vol. 8 (48). P. 250–255.

28. Serial evaluation of physiologic, pathological, and behavioral changes related to disease progression of experimentally induced Mannheimia in postweaned calves / G. Hanzlicek et al. *Am. J. Vet. Res*. 2010. V. 71. P. 359–369.

29. The effect of respiratory diseases in calves on the serum protein electrophoretic pattern / C. Tóthová et al. *Acta Vet. Brno*. 2012. V. 81. P. 365–370.

30. Tóthová C., Nagy O., Kováč G. The serum protein electrophoretic pattern and acute phase proteins concentrations in calves with respiratory diseases. *Acta Vet*. 2013. V. 63. P. 473–486.

Vol. 5. P. 169–174.

27. Romanenko T., Bevz A. Modern technology for the solution of livestock buildings reconstruction using the rules of design of beef production enterprises. *Collection of scientific works of VNAU*. 2011. Vol. 8 (48). P. 250–255.

28. Serial evaluation of physiologic, pathological, and behavioral changes related to disease progression of experimentally induced Mannheimia in postweaned calves / G. Hanzlicek et al. *Am. J. Vet. Res*. 2010. Vol. 71. P. 359–369.

29. The effect of respiratory diseases in calves on the serum protein electrophoretic pattern / C. Tóthová et al. *Acta Vet. Brno*. 2012. Vol. 81. P. 365–370.

30. Tóthová C., Nagy O., Kováč G. The serum protein electrophoretic pattern and acute phase proteins concentrations in calves with respiratory diseases. *Acta Vet*. 2013. Vol. 63. P. 473–486.

Received: April 26, 2023
Accepted: July 13, 2023