



## PULMONARY GAS EXCHANGE OF BULL-CALVES AND HEIFERS OF UKRAINIAN BLACK-SPECKLED DAIRY BREED AT DIFFERENT AGES

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**Abstract.** Studies of gas exchange in young cattle at different ages are important in terms of energy saving technologies, where the effective ways of energy accumulation in the body of animals or livestock production are justified.

Studies of gas exchange in bull-calves and heifers of Ukrainian black-and-motley dairy breed have shown that exchange processes take place more intensively in bull-calves. This increased the gains of live weight.

**Key words:** gas exchange, young cattle, exchange processes, age, live weight.

**Анотація.** Визначення газообміну молодняку великої рогатої худоби у різні вікові періоди є актуальним в умовах енергоощадних технологій, де обґрунтовуються шляхи ефективного накопичення енергоносіїв у тілі тварин, або у виробництві продукції тваринництва.

Дослідження газообміну молодняку української чорно-рябої молочної породи показали, що більш інтенсивно проходять обмінні процеси у бичків, це привело до збільшення приростів живої маси.

**Ключові слова:** газообмін, надремонтний молодняк, обмінні процеси, вік, жива маса.

**INTRODUCTION.** For many years the use of non-breed young dairy cattle in beef production is one of the major sources of meat in the agricultural sector of Ukraine [1].

The energy resources of feeding and keeping significantly affect the level of metabolism in the animals' body [2]. The production potential of beef cattle is one of the hereditary elements determining the level of metabolic processes, which have to comply with genetic makings of young cattle [3].

New approaches to provide animals' life activity come from the improving of technological solutions in the reconstruction of livestock buildings that will allow to determine the level of metabolism in young cattle and improve the efficiency of beef production [4].

The capacity of farms is decreased to 100 – 200 cows, so they need new approaches to livestock production, including the beef one. The introduction of new department rules of technological design in the Agro-industrial complex – 01.05 allows to place every small farm in one building. Scientific approaches to specific technological solutions for the use of existing livestock buildings, especially when feeding young cattle, are required [5].

Thus, the studies of gas exchange in young cattle at different ages are important in terms of energy saving technologies, where the effective ways of energy accumulation in the body of animals or livestock production are justified.

The purpose of research is to determine the level of pulmonary gas exchange in young cattle of Ukrainian black-speckled dairy breed at different ages and justify it in the male and female cattle.

**MATERIAL AND METHODS.** Pulmonary gas exchange was studied in the bull-calves and heifers at 15 and 18 months of age. The experimental animals were selected on the basis of groups-analogues by gender, age and live weight close to the average. Each group included 4 heads at the age of 15 and 18 months. Pulmonary gas exchange was studied under the "mask method" (V. Kimakhovski, 1985; A. Tsvihun, 1993) by 5 minute sessions before the morning feeding. The analysis of inhaled and exhaled air was conducted on the portable gas analyzer ARS-100.

The live weight was determined by individual weighting of bull-calves and heifers at the age of 15 and 18 months, as well as by the preliminary zootechnical account. The similar studies were conducted on heifers.

The biometric data processing was performed by means of variational statistics method according to M. Plokhynskiy (1969), V. Patrov and co-authors (2000).

Pulmonary gas exchange reflects the total level and direction of metabolic processes in the body of animals. It is one of the most important factors for the formation of meat productivity of bull-calves and heifers of Ukrainian

black-speckled dairy breed when taking into account the diversity and complexity of the metabolic processes in their body.

The amount of consumed oxygen and exhaled carbon dioxide are the indicators of metabolism and energy intensity in the body of animals.

**RESEARCH RESULTS.** Pulmonary gas exchange in animals shows that the level of metabolic processes in the body depends on many factors, primarily on the breed, age, sex, air temperature and humidity, as well as the level and type of feeding.

The research of pulmonary gas exchange in bull-calves of Ukrainian black-speckled dairy breed at the age of 15 months has shown that under the average live weight of 398.2 kg, the respiratory rate was 25.75 times per minute. It increased by 7.8% ( $R \leq 0.01$ ) up to 18 months of age (Table 1).

Table 1 shows that the amount of oxygen consumed at the age of 15 months was 2377.55 ml per minute, while it increased by 15.54% (at  $R \leq 0,001$ ) at the age of 18 months. On the contrary it decreased by 3.2% (at  $R \leq 0,001$ ) per 1 kg of live weight.

The amount of carbon dioxide exhaled by bull-calves has increased by 12.6% for the period of three months (15-18 months). But the increase by 76.5 kg of live weight led to the reduction by 5.5% (at  $R \leq 0,001$ ) of exhaled carbon dioxide per 1 kg of live weight. As a result, the respiratory rate was set at a high level of 0.958 (15 months) and 0.935 (18 months.).

It has been determined that continued feeding of

Table 1

**PULMONARY GAS EXCHANGE IN BULL-CALVES OF UKRAINIAN BLACK-SPECKLED DAIRY BREED, N=4 ( $\bar{x} \pm S\bar{x}$ )**

Indicator	Age, months		18 months in % to 15 months
	15	18	
Live weight, kg	398,2±1,95	474,7±1,73****	119,2
Respiratory rate, times/min	25,75±0,32	27,75±0,42***	107,8
Ventilation of breathing, l/min	125,14±1,82	122,98±2,21**	102,2
Depth of breathing, liters/times	4,86±0,028	4,41±0,048****	110,2
Amount of oxygen consumed per 1 kg of live weight, ml/min	5,97±0,034	5,78±0,034****	96,8
Amount of consumed oxygen, ml/min	2377,55±24,96	2743,77±15,99****	115,36
Amount of exhaled carbon dioxide, ml/min	2277,41±19,25	2565,42±20,25****	112,6
Amount of exhaled carbon dioxide per 1 kg of live weight, ml/min	5,72±0,030	5,40±0,036****	94,5
Respiratory rate	0,958±0,006	0,935±0,005**	102,4

Note:  $P \leq 0,1^*$ ;  $P \leq 0,05^{**}$ ;  $P \leq 0,01^{***}$ ;  $P \leq 0,001^{****}$ ;



Ukrainian black-speckled dairy breed up to 18 months of age will have not only a positive impact on the increase in live weight, but won't suffer significant losses in metabolism. Relevant differences were observed in the pulmonary gas exchange in heifers at the age of 15 and 18 months.

Table 2 shows that for three months the live weight of heifers has increased by 19.8% from 331.0 kg to 396.7 kg, while the respiratory rate has decreased by 5.1%. Significant difference has not been determined.

Ventilation of heifers' breathing at 15 months of age was by 11.8% more while the depth of breathing was 4.54 liters / times and 4.22 liters / times per one breath respectively, that is 7.1% ( $R \leq 0,001$ ) less. Live weight increases

Table 2  
**PULMONARY GAS EXCHANGE IN HEIFERS OF UKRAINIAN BLACK-SPECKLED DAIRY BREED, N=4 ( $\bar{x} \pm S\bar{x}$ )**

Indicator	Age, months		18 months in % to 15 months
	15	18	
Live weight, kg	331,0±5,37	396,7±5,33****	119,8
Respiratory rate, times/min	19,5±0,56	18,5±0,56	94,9
Ventilation of breathing, l/min	88,53±2,03	78,07±5,01	88,2
Depth of breathing, liters/times	4,54±0,05	4,22±0,06***	92,9
Amount of oxygen consumed per 1 kg of live weight, ml/min	5,30±0,05	5,12±0,06**	96,6
Amount of consumed oxygen, ml/min	1754,3±25,65	2031,1±11,85****	115,8
Amount of exhaled carbon dioxide, ml/min	1324,5±41,76	1381,1±20,25	104,3
Amount of exhaled carbon dioxide per 1 kg of live weight, ml/min	4,00±0,32	3,48±0,18	82,0
Respiratory rate	0,755±0,025	0,680±0,035	111,0

Table 3  
**COMPARATIVE ASSESSMENT OF PULMONARY GAS EXCHANGE IN BULL-CALVES AND HEIFERS AT THE AGE OF 15 AND 18 MONTHS, %**

Indicator	Bull-calves in the percentage to heifers, months	
	15	18
Respiratory rate, times/min	132,5	150,0
Ventilation of breathing, l/min	141,3	157,5
Depth of breathing, liters/times	107,0	104,5
Amount of consumed oxygen, ml/min	135,5	135,1
Amount of oxygen consumed per 1 kg of live weight, ml/min	112,6	112,9
Amount of exhaled carbon dioxide, ml/min	171,9	189,5
Amount of exhaled carbon dioxide per 1 kg of live weight, ml/min	143,0	155,2
Respiratory rate	126,9	137,5

with age, the total amount of consumed oxygen increases by 15.8%, while the amount of exhaled carbon dioxide per 1 kg of live weight decreases by 3.4%.

The comparative assessment of pulmonary gas exchange in bull-calves and heifers at the age of 15 and 18 months is given in Table 3.

The amount of exhaled carbon dioxide for three months increased by 4.3% while it decreased by 13% per 1 kg of live weight. Therefore, the respiratory rate was 0.755 (bull-calves) and 0.680 (heifers).

The studies have shown that the respiratory rate of bull-calves of Ukrainian black-speckled dairy breed from the age of 15 months is by 32.05% more than that of heifers. It is by 50% more at the age of 18 months (Table 3).

Ventilation of bull-calves' breathing differed substantially compared with heifers. It was 125.14 l / min at the age of 15 months, while that of heifers was by 57.5% less. The depth of breathing was by 7.0% (15 months) and 4.5% (18 months) more.

The amount of oxygen consumed by bull-calves at the age of 15 months was by 35.2% more compared to heifers. The amount of oxygen consumed per 1 kg of live weight in bull-calves and heifers was 12.6 and 12.9%, respectively. At the same time the amount of carbon dioxide exhaled by bull-calves was by 71.9% (15 months) and 89.5% (18 months) more than by heifers. The respiratory rate of bull-calves was higher by 26.9% (15 months) and 37.5% (18 months).

Thus, the studies of gas exchange in bull-calves and heifers of Ukrainian black-speckled dairy breed have shown that the exchange processes take place more intensively in bull-calves. This increases the gains of live weight that leads to the accumulation of energy with age. Therefore, the continued keeping of bull-calves and heifers up to the age of 18 months has positive results.

## Conclusions

1. It is advisable to conduct the study of continued fattening of non-breed heifers and bull-calves of Ukrainian black-speckled dairy breed up to the age of 18 months in terms of feeding under the unleashed-boxed keeping and examine pulmonary gas exchange of bull-calves and heifers of Ukrainian black-speckled dairy breed.
2. The studies of gas exchange in bull-calves and heifers of Ukrainian black-speckled dairy breed have shown that the exchange processes take place more intensively in bull-calves. This has increased the gains of live weight. Therefore, the respiratory rate of bull-calves is higher by 26.9% (15 months of age) and 37.5% (18 months of age) compared with heifers.
3. It is advisable to use the unleashed-boxed keeping in the fattening of young cattle of Ukrainian black-speckled dairy breed.

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