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GAS-ENERGY EXCHANGE oF COWS WITH VARIOUS POLYMORPHISM ASSOCIATIONS IN GH AND PIT-1 GENES

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ГАЗОЭНЕРГЕТИЧЕСКИЙ ОБМЕН У КОРОВ С РАЗЛИЧНЫМИ АССОЦИАЦИЯМИ ПОЛИМОРФИЗМОВ В ГЕНАХ GH И PIT-1

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Abstract:

The aim of the work is to study the influence of genotype with different polymorphism associations in GH and PIT-1 genes on the characteristics of pulmonary respiration and gas-energy exchange with intensive use of high-producing Holstein cows.

Materials and methods. The researches were conducted on Holstein half-sister cows. PCR method was used to determine the polymorphism of growth promoting hormone marker genes GH and PIT-1. Animals were divided into 3 groups of 7 units in each depending on the genotype: LL/AB, LL/BB and LV/BB. Gas-energy exchange of cows was performed using a special mask with a back-flow valve and a gas-analyzer.

Results. Cows of genotypes LL/AB and LL/BB dominated peers of LV/BB genotype by milk yield for 305 days of the second lactation by 9.8 and 13.5%, milk fat by 9.8 and 13.2%, and milk protein by 9.8 and 13.8%. Compared to cows of LV/BB genotype, cows of LL/AB complex genotype had an advantage in indexes of oxygen consumption, carbon dioxide emission and heat production.

Conclusions. It was determined that the genotype of cows with different polymorphism associations in the GH and PIT-1 genes affects the characteristics of pulmonary respiration and gas-energy exchange of cows. Cows of LL/AB genotype were characterized by a higher metabolic status of the organism, and together with cows of LL/BB genotype performed better lactotropic, protein-synthesizing and fat-stimulating functions than their peers of LV/BB genotype.

Аннотация:

Цель роботы – исследовать влияние генотипа с разной ассоциацией полиморфизмов в генах GH и PIT-1 на признаки легочного дыхания и газоэнергетического обмена при интенсивном использовании высокопродуктивных коров голштинской породы.

Материал и методы. Исследования проводились на коровах полусетрах голштинской породы. Для определения полиморфизма маркерных генов гормона роста GH и PIT-1 использовали метод ПЦР. Животных разделяли на 3 группы в зависимости от генотипа: LL/AB, LL/BB и LV/BB по 7 животных в группе. Газоэнергетический обмен у коров выполнили с применением специальной маски с обратным клапаном и газоанализатора.

Результаты. Коровы генотипов LL/AB и LL/BB преобладали над сверстницами генотипа LV/BB по надоям за 305 суток второй лактации на 9,8 и 13,5%, выходом молочного жира на 9,8 и 13,2% и молочного белка на 9, 8 и 13,8%. По сравнению с коровами генотипа LV/BB по показателю потребления кислорода, выделением углекислоты и теплопродукции преимущество имели коровы комплексного генотипа LL/AB.

Выводы. Установлено, что генотип коров с разной ассоциацией полиморфизмов в генах GH и PIT-1 влияет на признаки легочного дыхания и газоэнергетического обмена коров. Коровы генотипа LL/AB характеризовались высоким метаболическим статусом организма, а также вместе с генотипом LL/BB лучше выполняли лактотропную, белок синтезирующую и жиро стимулирующую функцию, чем их сверстницы генотипа LV/BB.

Keywords: Holstein breed; genetic markers; milk productivity; oxygen consumption; carbon dioxide emission; heat production.

Ключевые слова: голштинская порода; генетические маркеры; молочная продуктивность; потребление кислорода; выделение углекислоты; теплопродукция.

1. Introduction

Current methods of selection are directed on the forming the higher metabolic status of the organism, the strong body structure and the spontaneous resistance of the herd animals [12, 14]. The introduction of new scientifically based genetic methods for the estimating and selection of animals are required because the increase of the cattle genetic potential is largely determined by the availability of information about the genetic nature of productivity characteristics [10, 13].

The influence of feeding and environmental factors on the metabolic status of animals has already been studied. The inclusion of iodine, cobalt, copper and zinc salts in the cattle diet increases gas exchange and heat production [5]. Gas exchange increases in summer and decreases in winter [11] and it depends on the type of nervous system, in particular cows with high tolerance for stress have higher level of gas exchange [4]. During lactation, pulmonary gas exchange and heat production are higher than in the dry cow period, which is due to the intense activity of the lacteous gland and other body systems. In particular, the decrease of the metabolic status of cows with age in lactation is noted by Kapshuk N.O. [2]. The most productive dairy cows are characterized by more intensive oxygen consumption, carbon dioxide emission and heat production than less productive animals [3].

Thus, the literature shows that the intensity of gas-energy exchange depends on feeding, age, type of nervous system, productivity, physiological state of the animal and other factors. The influence of genotype with different associations of polymorphism in GH and PIT-1 genes on the characteristics of pulmonary respiration and gas-energy exchange with intensive use of high-producing Holstein cows remains unsearched, and it was the main aim of this study.

2. Materials and Methods

The research was carried out in the Private Joint Stock Company «Agro-Soiuz» in Dnipropetrovsk region (Ukraine) with Holstein breed peers which were the daughters of a seed bull Kashemir 131671771.

DNA isolated from animal blood was examined. PCR method was used to determine the polymorphism of the growth promoting hormone marker genes GH and PIT-1[1]. The research was conducted under the guidance of specialists from the Laboratory of Genetic Control, Poltava. Isolation of genomic DNA was performed using resin "Chelex-100". The reaction was performed in a thermocycler "Tertsyk". Electrophoretograms were documented using a Canon digital camera.

Gas-energy exchange of cows was performed using a special mask with a back-flow valve [9]. The following absorbing solutions were used: 15% solution of pyrogallol A for oxygen, 10% solution of *KOH* for carbon dioxide. The total volume of air breathed out by the animal for 5 minutes was set with a gasometer. The volume of air breathed out per minute was determined by dividing the total volume of breathed out air in the minutes the animal spent for breathing.

Statistical processing of the material was performed in Microsoft Excel. The data in the tables are presented in the form of $x \pm S_x$.

3. Results

Milk productivity of cows depended significantly on their genetic peculiarities caused in particular by the association of growth promoting hormone genes GH and PIT-1 (Table 1).

Table 1

Milk productivity of Holstein semi-sib cows during the second lactation

Characteristic	Genotype					
	LL/AB (n = 33)		LL/BB (n = 64)		LV/BB (n = 8)	
	$\bar{X} \pm S_{\bar{X}}$	*Cv*,%	$\bar{X} \pm S_{\bar{X}}$	*Cv*,%	$\bar{X} \pm S_{\bar{X}}$	*Cv*,%
Milk yield for 305 days, kg	12037 ± 190.8**	9.1	11643 ± 148.2**	10.2	10607 ± 361.1	8.3
Fat content, %	3.69 ± 0.005	3.8	3,68 ± 0,008	3.1	3.70 ±0.019	3.5
Amount of milk fat, kg	444.2 ± 7.19**	9.3	428.5 ± 5.51*	10.3	392.5 ± 13.26	8.3
Protein content, %	3.20 ± 0.007	2.3	3.19 ± 0.005	2.2	3.19 ± 0.015	2.1
Amount of milk protein, kg	385.2 ± 6.14**	9.2	371.4 ± 4.68**	10.1	338.4 ± 12.01	8.7

*Note: *(P < 0.05), **(P < 0.01) compared with the genotype LV/BB.*

Compared with cows of genotype LV/BB, the cows of genotype LL/AB had heavier milk yield for 305 days of second lactation by 1430 kg (P<0.01), higher amount of milk fat and protein by 51.7 kg (P <0.01) and 46.8 kg (P <0.01), respectively; the cows of genotype LL/BB had heavier milk yield by 1036 kg (P <0.01), higher amount of milk fat and protein by 36.0 kg (P <0.01) and 33.0 kg (P <0.01), respectively.

In researches we assumed that the high milk productivity of cows depends significantly on the genetically determined intensity of metabolic processes in the body and its ability to maintain balance with the environment (Table 2).

Table 2

Characteristics of pulmonary respiration of different genotype cows

Characteristic	Genotype		
	LL/AB, *n*=7	**LL/BB, *n*=7**	**LV/BB, *n*=7**
Respiration rate, breath/minute	23.1 ± 2.1	22.6 ± 1.8	22.2 ± 1.7
Lung ventilation, l/minute	93.6 ± 4.1	93.3 ± 5.2	92.1 ± 5.7
Respiration depth, l	3.74 ± 0.37	3.71 ± 0.25	3.87 ± 0.69
Lung ventilation, l/minute/kg	0.147 ± 0.018	0.151 ± 0.021	0.139 ± 0.027

Characteristics of pulmonary gas exchange of Holstein cows tended to vary depending on the association of growth promoting hormone genes in favour of LL/AB genotype animals, but with no reliable result. However, studies of the intensity of oxidative processes revealed a significant advantage of LL/AB genotype animals over their peers of LV/BB genotype (Table 3).

Table 3

Gas-energy exchange of different genotype cows

Characteristic	Genotype		
	LL/AB, *n*=7	**LL/BB, *n*=7**	**LV/BB, *n*=7**
Oxygen consumption, l/minute	4.23 ± 0.19	4.14 ± 0.23	3.79 ± 0.24
Carbon dioxide emission, l/minute	3.55 ± 0.17	3.48 ± 0.21	3.19 ± 0.22
Heat production, kJ/minute	85.9 ± 4.1	84.2 ± 4.8	77.1 ± 5.1
Oxygen consumption, ml/minute/kg	6.62 ± 0.26*	6.68 ± 0.36	5.74 ± 0.29
Carbon dioxide emission, ml/minute/kg	5.56 ± 0.22*	5.62 ± 0.31	4.83 ± 0.25
Heat production, kJ/hour/kg	8.06 ± 0.31*	8.15 ± 0.44	7.01 ± 0.36

*Note: *P<0.05 compared with LV/BB.*

In amounts of oxygen consumption, carbon dioxide emission and body heat production the difference between cows was statistically insignificant, but genotypes LL/AB and LL/BB showed a better value of markers. Marker of oxygen consumption of cows in all groups is high, but with an advantage of 0.88 l/minute/kg (P <0.05) in favour of LL/AB genotype animals and 0.94 l/minute in favour of the LL/BB genotype animals compared to peers of LV/BB genotype. Representatives of the first two genotypes breathed out more carbon dioxide by 0.73 ml/minute/kg (P <0.05) and 0.79 ml/minute/kg and predominated cows of LV/BB genotype in marker of heat production by 1.05 (P <0.05) and 1.14 kJ/hour/kg.

4. Discussion

The difference in the obtained data indicates that the cows of LL/AB genotype have a higher metabolic status. They have more intensive metabolism, which is explained by the fact that the gas-energy exchange of cows is directly dependent on the level of their milk productivity. According to researchers [3], the L allele of the GH growth promoting hormone gene and the A allele of the pituitary-specific positive transcription factor PIT-1 have the greatest lactotropic, fat- and protein-synthesizing function.

In the studies, the combination of these alleles in LL/AB complex genotype was the most productive with the highest level of gas-energy exchange. In other similar studies of cows in the Carpathian region of Ukraine, an increase in milk yield (15.0%, P <0.001) and protein content in milk (0.06% with P <0.01) was found in representatives of LL genotype with the GH gene [8]. Hradecka and co-authors highlighted the absence of any connection between genotypes with GH gene [6], while in other studies German Holstein cows with LL genotype of the GH gene were characterized by the heaviest milk yields [8].

Researches of the influence of polymorphism associations in these genes on the formation of body structure of cows and the economic efficiency of their use are advantageous in the longer term.

4. Conclusion.

The obtained data do not contradict the hypothesis that the genotype with different associations of polymorphism in GH and PIT-1 genes affects the characteristics of pulmonary respiration and gas-energy exchange of Holstein cows. The metabolic status of the organism is highest in LL/AB genotype of cows. The LL/AB and LL/BB genotypes perform a relatively better lactotropic, protein-synthesizing and fat-stimulating function than LV/BB genotype of cows.

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