

**ENZYMATIC ACTIVITY OF
NA⁺,K⁺-ADENOSINE TRIPHOSPHATASE IN ERYTHROCYTES OF
COWS DEPENDING ON TYPE OF HIGHER NERVOUS ACTIVITY**

V.I. KARPOVSKIY, Doctor of Veterinary Science,
Professor, Academician of ANVOU

D.I. KRYVORUCHKO, Candidate of Veterinary Science

R.V. POSTOY, Candidate of Veterinary Science

P.V. KARPOVSKIY, Post-Graduate student¹,

The results of study of enzymatic activity Na-, K- adenosine triphosphatase in erythrocytes of cows of different types of higher nervous activity are shown. Established that cows with high levels of strength, mobility and balance of nervous processes in the cerebral cortex have higher activity of studied enzyme compared with animals of weak type.

Key words: *type of higher nervous activity, erythrocytes, adenosine triphosphatase, blood, cows*

The improvement of cattle productivity is impossible without taking into consideration the physiological features of organism, its response to various technological stimuli, the ability of quick adaptation to changing environmental conditions. The type of higher nervous activity substantially affects the realization of cow's genetic potential for milk production determining the reactivity of organism to environmental factors including the irritation, which stimulates milk synthesis and milk removal [4].

In the researches of I.P. Pavlov and his students the theory of cortical and visceral connections, whereby the type of nervous system plays an important role in the implementation of autonomic body functions, is developed [3]. By its biological significance the conditioned reflexes are the most subtle adaptive responses of the

¹ Supervisor – Candidate of Veterinary Science, V.O. Trokoz

nervous system. Owing to the conditioned reflex the interaction of external stimuli with the organism is made at different levels of its organization, including the biochemical reactions [5].

Enzymes are necessary to carry out the biochemical reactions in order to regulate and direct metabolism. Literature data indicate a lack of study about the relationship between the enzyme systems and individual features of conditioned reflex activity in animals.

The purpose of research was to determine the activity of Na^+ , K^+ -adenosine triphosphatase in erythrocytes of cows of different types of higher nervous activity.

Materials and methods. The study was conducted on 20 cows of Ukrainian black and red milk breed during the second lactation kept at the farm “Heysyske” Stavyschenskiy district, Kyiv region in 2008-2011 years.

Types of higher nervous activity (HNA) in cows were determined by the method of food conditioned reflexes of G.V. Parshutin and T.V. Ipolitova [6] modified by the Department of Animal Physiology, Pathophysiology and Immunology of NULES of Ukraine [7]. We examined the strength, mobility and balance of excitation and inhibition in cerebral cortex of animals. According to definite typological specificities of nervous system we formed 4 experimental groups, 5 animals in each by the analogue method. The first group includes animals with strong balanced mobile, the second – strong balanced inertial, the third – strong unbalanced, and the fourth – weak types of HNA.

For the examinations blood samples were collected from the abdominal aorta and subcutaneous abdominal vein in compliance with asepsis and antisepsis rules. For the biochemical analysis we used blood plasma stabilized with sodium citrate 5% solution. Determination of Na^+ , K^+ -adenosine triphosphatase enzymatic activity was made in red blood cells which were prepared by blood plasma centrifugation at 3000 rev/min, then washed twice with saline [8]. The obtained results were analyzed according to generally accepted methods of statistics through the Microsoft Excel computer program.

Results and discussion. Adenosine triphosphatases (ATPase) – the class of hydrolases that catalyze the cleavage of phosphoric acid residue from the molecule of adenosine triphosphate. Functional activity of Na⁺, K⁺-adenosine triphosphatase is an integral indicator of changes in membrane environment of enzyme, the state of cell antioxidant systems, specificity of cellular regulatory mechanisms that simulate its activity [2]. Exactly the activity of this membrane-associated enzyme provides transport of energy and structural materials through the cell membrane, membrane potential and osmotic stability of cytoplasm [1].

In our studies we found that cows with strong types of HNA (strong balanced mobile, strong balanced inert and strong unbalanced) have significantly higher activity of Na⁺, K⁺-ATPase in erythrocytes of arterial blood than cows of weak type (Table).

1. Activity of Na⁺,K⁺- ATP-ase in erythrocytes of cows of different types of higher nervous activity, M±m, n=5

Type of higher nervous activity	Activity of Na ⁺ ,K ⁺ - ATP-ase, mkmol Pi/mg hours	
	Arterial blood	Venous blood
Strong balanced mobile	0.30±0.01*	0.29±0.01**
Strong balanced inertial	0.29±0.01*	0.27±0.01*
Strong unbalanced	0.28±0.01*	0.27±0.02*
Weak	0.22±0.02	0.22±0.02

* – p<0.05, ** – p<0.01 comparatively weak type of HNA

The activity of this enzyme in erythrocytes of arterial blood in cows of strong balanced mobile type of HNA was 0.30 ± 0.01 mmol Pi / mg h, what is 26.67 % (p <0.01) more than in cows of weak type. In animals of strong balanced inert and strong unbalanced types of HNA the activity of Na⁺, K⁺-ATPase in erythrocytes was slightly lower compared with animals of strong balanced mobile type, but higher than the indices in animals of weak type respectively 24.14 and 21.43% (p<0.05).

The activity of Na^+ , K^+ -ATPase in erythrocytes of venous blood in all cows tended to decrease compared with its activity in arterial blood. In cows of strong balanced mobile type of HNA the activity of this enzyme in erythrocytes of venous blood was 24.14% ($p < 0.01$) higher than in cows of weak type. Animals of strong balanced inert and strong unbalanced types of HNA were characterized by the same activity of Na^+ , K^+ -ATPase in erythrocytes of venous blood, but the value of its activity in representatives of these two types of HNA was 18.52% ($p < 0.05$) higher in compare with animals of weak type.

Established positive correlation between activity of Na^+ , K^+ -ATPase in erythrocytes of arterial ($r = 0.60$, $p < 0.01$) and venous ($r = 0.61$, $p < 0.01$) blood and strength of excitation and inhibition in cerebral cortex (Figure).

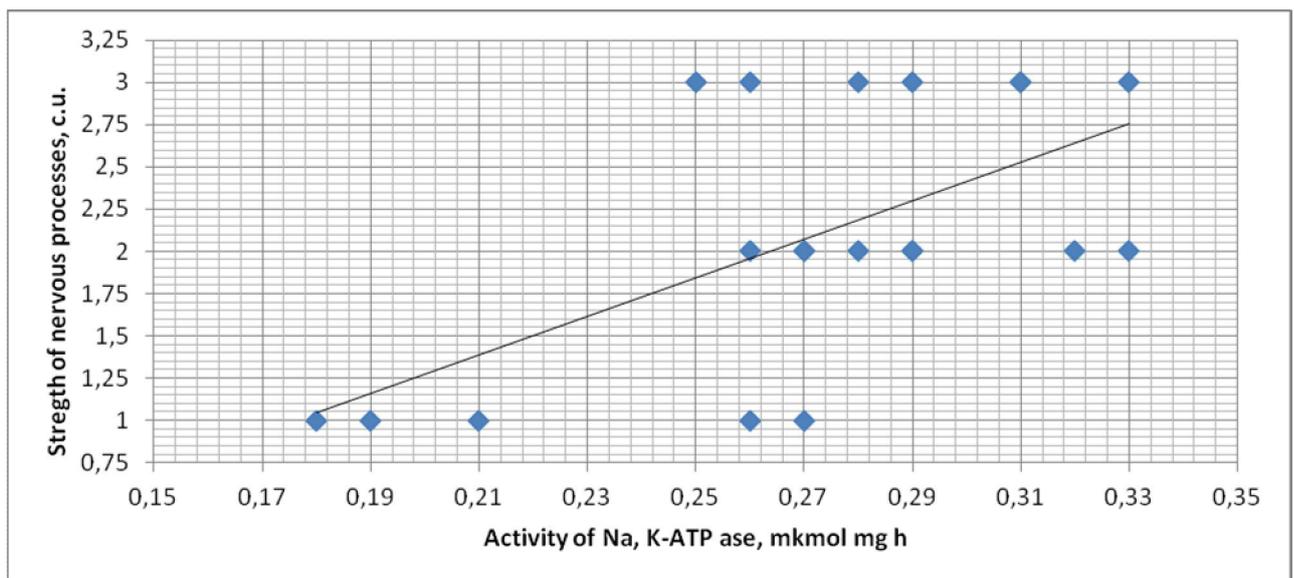


Figure. Correlation between the enzymatic activity of Na^+ , K^+ -ATPase in erythrocytes of cows and strength of nervous processes.

Thus, in cows of strong balanced mobile, strong balanced inert and strong unbalanced types of HNA active of Na^+ , K^+ -ATPase in erythrocytes of arterial and venous blood was significantly higher than in cows of weak type.

The glycolytic pathway of the splitting glucose is less energetically beneficial than oxidative phosphorylation, but plays an important role in metabolism. From the

research of Ken Okamoto et al. [9] it is known that adenosine triphosphate, which is formed by glycolysis, is the predominant source of energy for the Na^+ , K^+ - adenosine triphosphatase. At the same time there is a direct correlation between the level of aerobic glycolysis and activity of Na^+ , K^+ - adenosine triphosphatase [10]. Our studies have shown that cows with strong types of higher nervous had significantly higher activity of Na^+ , K^+ - adenosine triphosphatase than cows of weak type. The most appreciable difference was observed between the marginal types of higher nervous activity. Established the correlation between the strength of nerve processes and studied enzyme activity in erythrocytes.

Conclusion. The activity of Na^+ , K^+ - adenosine triphosphatase in erythrocytes of cows with strong nerve processes is 18.5-26.7% ($p < 0.05$) higher than the value of this indicator in cows of weak type, what is the evidence of high activity of transmembrane transport of substances in cells of cows with strong types of higher nervous activity.

REFERENCES

1. Исследование активности Na^+ , K^+ -АТФ-азы в мембранах эритроцитов в динамике нитритной метгемоглобинемии / О.Н. Филиппова, И.А. Шперлинг, В.В. Новицкий [и др.] // Фундаментальные исследования. – 2005. – № 4. – С. 91.
2. Капля А.А. Функционирование Na^+ , K^+ -АТФ-азы в поляризованных клетках / А.А. Капля, В.С. Морозова // Укр. біохім. журн.– 2010.– Т. 82, № 1. – С.5–20.
3. Кокорина Э.П. Условные рефлексы и продуктивность животных / Э.П. Кокорина. – М.: Агропромиздат, 1986. – 335 с.
4. Кравайнис Ю.Я. О молочной продуктивности коров с разным типом высшей нервной деятельности / Ю.Я. Кравайнис // Сельскохозяйственная биология. Серия: Биология животных. – 2006. – № 2. – С. 52–56.
5. Кряжев, В.Я. Высшая нервная деятельность животных в условиях общения: монография / В. Я. Кряжев. – М.: Медгиз, 1955. – 235 с.

6. Паршутин Г.В. Типы высшей нервной деятельности, их определение связь с продуктивными качествами животных / Г.В. Паршутин, Т.В. Ипполитова. – Фрунзе: Киргизстан, 1973. – 72 с.

7. Патент України на корисну модель № 16138, МПК (2006) А61В 5/16. Спосіб оцінки властивостей нервових процесів у великої рогатої худоби / Азар'єв В.В., Карповський В.І., Трокоз В.О., Костенко В.М., Криворучко Д.І. – № u20060 2200; заявл. 28.02.2006; опубл. 17.07.2006, Бюл. №7.

8. Прохорова М.И. Методы биохимических исследований (липидный и энергетический обмен): [учеб. пособие] / М.И. Прохорова – Л.: Изд-во Ленингр. ун-та, 1982. – 272 с.

9. ATP from glycolysis is required for normal sodium homeostasis in resting fast-twitch rodent skeletal muscle / [Ken Okamoto, Weiyang Wang, Jan Rounds et al.] // Am. J. Physiol. Endocrinol. Metab. – 2001. – Vol. 281, No. 3. – P. E479–E488.

10. Role of Na⁺,K⁺-ATPase in insulin-induced lactate release by skeletal muscle / [Valérie Novel-Chaté, Valentine Rey, René Chioléro et al.] // Am. J. Physiol. Endocrinol. Metab. – 2001. – Vol. 280, No. 2. – P. E296–E300.

**ФЕРМЕНТАТИВНАЯ АКТИВНОСТЬ NA⁺/K⁺-
АДЕНОЗИНТРИФОСФАТАЗЫ В ЭРИТРОЦИТАХ КОРОВ В
ЗАВИСИМОСТИ ОТ ТИПА ВЫСШЕЙ НЕРВНОЙ ДЕЯТЕЛЬНОСТИ**

В.И. Карповский, Д.И. Криворучко, Р.В. Постой

Приведены результаты исследования ферментативной активности Na-, K-аденозинтрифосфатазы в эритроцитах коров разных типов высшей нервной деятельности. Установлено, что у коров с высокими показателями силы, подвижности и уравновешенности нервных процессов в коре большого мозга наблюдается более высокая активность исследуемого фермента по сравнению с животными слабого типа.

Ключевые слова: тип высшей нервной деятельности, эритроциты, аденозинтрифосфатаза, кровь, коровы

**ФЕРМЕНТАТИВНА АКТИВНІСТЬ Na^+/K^+ -
АДЕНОЗИНТРИФОСФАТАЗИ В ЕРИТРОЦИТАХ КОРІВ ЗАЛЕЖНО ВІД
ТИПУ ВИЩОЇ НЕРВОВОЇ ДІЯЛЬНОСТІ**

В.І. Карповський, Д.І. Криворучко, Р.В. Постой

Наведено результати дослідження ферментативної активності Na^+/K^+ -аденозинтрифосфатази у еритроцитах корів різних типів вищої нервової діяльності. Установлено, що у корів із високими показниками сили, рухливості та врівноваженості нервових процесів у корі великого мозку спостерігається вища активність досліджуваного ензиму порівняно з тваринами слабкого типу.

Ключові слова: тип вищої нервової діяльності, еритроцити, аденозинтрифосфатаза, кров, корови