UKRAINIAN JOURNAL OF VETERINARY SCIENCES

2023. Volume 14, No. 3. P. 85-99

Received: 30.03.2023 Revised: 29.06.2023 Accepted: 11.08.2023

DOI: 10.31548/veterinary3.2023.85

UDC 636.2.09:615.35:616.8

Influence of autonomic nervous system tone on the content of cholesterol and lipoproteins of different density in the blood of cows

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Suggested Citation:

Króliczewska, B., Hryshchuk, I., Karpovskyi, V., Zhurenko, O., & Todoryuk, V. (2023). Influence of autonomic nervous system tone on the content of cholesterol and lipoproteins of different density in the blood of cows. *Ukrainian Journal of Veterinary Sciences*, 14(3), 85-99. doi: 10.31548/veterinary3.2023.85.

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Abstract. The relevance of the study lies in the investigation of the influence of the autonomic nervous system tone on the content of lipids in the body of cows, which is important to consider in order to ensure the high productivity of the dairy herd and balance diets in animal feeding. The purpose of the study was to determine the effect of the tone of the ganglion nervous system on the content of cholesterol and lipoproteins of various densities in the blood of dairy cows of the Ukrainian Black-and-White breed. To determine heart rate variability, an electrocardiograph was used with subsequent measurement of the main indicators according to the Baevsky stress index, which included determining the mode, its amplitude, variation range, autonomous equilibrium index, autonomous rhythm indicator, and stress index. Three experimental groups were formed from experimental cows: normotonics, vagotonics, and sympathotonics. The content of lipoproteins in blood plasma was determined using a Sinnova BS-3000 biochemical analyser (China). According to the results of biochemical analysis, differences in the obtained indicators were established among experimental groups of cows with different tones of the autonomic nervous system. This is due to the fact that activation of the sympathetic nerve branch leads to changes in liver function, which affects the production of glucose in the body. This can lead to increased cholesterol production. In addition, an increased tone of the sympathetic branch can stimulate the activity of enzymes responsible for the synthesis of cholesterol, and lead to a decrease in the level of hormones that regulate its synthesis and transport in the body. In particular, vagotonic animals had the highest blood content of total cholesterol and high-density lipoproteins. Sympathotonics showed the lowest blood values for total cholesterol and high-density lipoproteins. Normotonics occupied an intermediate place among the experimental groups of cows. A detailed study of this issue reveals the features of the influence of the autonomic nervous system tone on the indicators of lipid metabolism in the blood of cows, which is important to consider in production to effectively solve issues related to maintaining their productivity and improving the quality of milk

Keywords: ganglion nervous system; normotonics; vagotonics; sympathotonics; lipids; Ukrainian Black-and-White

Introduction

Lipid metabolism in cattle differs compared to monogastric animal species. Lipids, which are part of cell membranes, are directly involved in the processes of transmembrane active transport of molecules and ions, specific reception on the cell surface, transmission of nerve impulses, etc. Since cell membranes are important regulators of many biochemical processes, changes in the structure, composition, and orientation of membrane lipids cause significant disruption of cellular metabolism. It is quite important to properly balance the diet for highly productive cows. It should also be noted that during the lactation period, the content of lipids in the cow's blood significantly increases compared to the interlactation period. This is especially common before calving. During this period, an increase in blood lipids can be observed, which even goes beyond the normal range (Davis *et al.,* 2019). Despite these changes, they are assessed as a physiological phenomenon, as lipid content decreases and their concentration gradually normalises. Given these features, many factors should be taken into account on modern dairy farms to better balance diets and maintain homeostasis in the body of

highly productive animals (Gross *et al.,* 2021). A thorough understanding of this issue plays an important role in countering the growth of excess lipids in the body of cows, which can cause diseases (Ying *et al.,* 2021).

The study of lipid metabolism by O.P. Vergeles *et al.* (2019) focused primarily on the main indicators such as the main lipid depot and factors that have a significant impact on metabolic processes. The liver and subcutaneous tissue are the most important sites in the body where lipolysis and lipogenesis are constantly occurring (Sylvers-Davie & Davies, 2021). These processes are significantly influenced by diet and neurohumoral factors. The content of triglycerides in adipose tissue and the concentration of free fatty acids in the bloodstream depend on the uniform course of lipolysis and lipogenesis. For the transport of lipids in the cow's body, there is a specific list of lipoprotein transport systems. This provides a certain intensity of metabolic processes in other tissues, especially in the muscle and liver. To balance and control homeostasis, the central nervous system corrects the course of metabolic processes, affecting the activity of the corresponding hormones with the involvement of the peripheral nervous system (Basu & Goldberg, 2020).

According to K.R. Feingold (2022), the autonomous nervous system, as one of the components of the peripheral nervous system, has a corrective effect on the intensity of metabolic processes in the body of cows. The liver, with the help of the sympathetic and parasympathetic nervous systems, with the participation of afferent and efferent nerve fibres, provides an opportunity to communicate with regulatory centres in the brain, including the hypothalamus. Hypothalamic anorexic and orexigenic peptides transmit nerve signals to the liver, which provides modulation of lipid content and lipoprotein synthesis (Yang *et al.,* 2022a). Moreover, hormones such as insulin, leptin, glucagon-like peptides, control the concentration of lipids due to their action on peripheral nerves (Wen *et al.,* 2022).

Depending on the individual characteristics of the cow's body, the influence of the autonomous nervous system may vary. It is known that the sympathetic and parasympathetic nervous systems constantly affect the animal, but depending on circumstances, such as stress, one department may prevail over the other, which is the physiological norm. The relationship between these divisions is characterised as a sympathovagal balance, which may vary depending on the tone of the autonomic nervous system. To date, it has been determined that depending on the strength of the influence of the sympathetic or parasympathetic nervous system in the animal's body, it can be characterised as sympathotonia, vagotonia, and normotonia. Based on this, the individual intensity of metabolism in cows may vary. This, in turn, is the basis for studying this issue, for a better understanding of the processes of lipid metabolism in the body and its correction (Umezaki *et al.,* 2021). With this in mind, the purpose of this study is to investigate the effect of the tone of the autonomic nervous system on the content of lipoproteins in the blood of cows of the Ukrainian Black-and-White breed with high dairy productivity.

Literature Review

The most common agro-industrial sector in animal husbandry is the production of meat and dairy products. First of all, it is focused on increasing the number of highly productive cows. For this purpose, work is actively underway to determine the genetic characteristics of the body and the metabolic status of animals. Highly productive cows are sensitive to the conditions of keeping, which affects the ability of the animal body to maintain homeostasis of

the internal environment. Most often, the biological material for conducting diagnostic studies of the functional state of the animal's body is blood or its derivatives, such as plasma or serum (Gonçalinho *et al.,* 2021; Razzaghi *et al.,* 2022).

One of the informative characteristics of the physiological status of the body of cattle is the indicators of lipid metabolism. Among the most important components of the blood lipidogram are triacylglycerols and cholesterol. Considerable interest in the need to determine the content of lipids in the body of cows is explained by the fact that this indicator reflects the effectiveness of fat absorption by tissues quite well. This allows predicting the likely quality of meat and milk in the future. Cholesterol also plays an important role in the transport of free fatty acids in the body. With the help of combinations with proteins in the form of lipoproteins of various densities, the necessary energy-valuable lipids are gradually carried through the liver during digestion. Subsequently, they enter the subcutaneous tissue and participate in lipolysis and lipogenesis (Chen *et al.,* 2020*;* Daradics *et al.,* 2021).

Currently, areas are actively developing to improve these processes and ensure a better intake of the necessary amount of free fatty acids in the body of cows. This is due to the fact that to obtain an increase in milk productivity with the required percentage of fat content, it is necessary to ensure effective assimilation of high-energy substances. First of all, this is ensured by adding various feed additives and adjusting the diet in accordance with the needs of cows. However, not only balanced feeding can provide everything necessary for the animal's body. There are many factors influencing the assimilation and use of exogenous lipids in the digestive canal of productive animals (Cai *et al.,* 2022).

Neurohumoral regulation of homeostasis of the animal body is a fairly common question that arises in the study of lipid metabolism. Under the influence of external factors of the animal through various systems, depending on the nature of the influence of exo- or endogenous factors, the body uses or stores the necessary nutrients for its own needs. Correction of these processes is carried out with the help of both the central and peripheral nervous systems. In accordance with this, a certain amount of hormones is released, as well as nerve impulses are transmitted to the target organs to ensure and maintain homeostasis in the mammalian body. A fairly new question in the study of these processes was the determination of the role of the autonomic nervous system in the regulation of lipid metabolism (Rahman *et al.,* 2022). Due to the corresponding parts of the sympathetic and parasympathetic nervous systems, an active response of the body to factors that contribute to the violation of homeostasis in the body is established. Depending on the individual characteristics of the animal's body, the influence of each of these departments may differ in accordance with the tone of the autonomic nervous system.

Materials and Methods

The research was carried out in 2022 on cows of the Ukrainian Black-and-White dairy breed at the dairy farm of LLC "Obriy" (Poltava region, Orzhytskyi district, Vyshneve village). The variational pulsometry study involved 100 clinically healthy cows, 3-4 lactation. In the electrocardiographic study of experimental cows, a single-channel electrocardiograph Heart Mirror IKO (Hungary) was used to record changes in the electrical potentials of the heart. During the variational pulsometry, the animals were at rest. To obtain an electrocardiogram, the animals were fixed in a standing position of the body. At the attachment points of the device's sensors, the skin surface was previously freed from hair, treated with alcohol, and an electrically conductive gel was applied, which allowed avoiding artifacts during heart rate recording.

Three anatomical points were used to perform the variational pulsometry. The first one was placed on the left side between 3-5 intercostal spaces, behind the elbow. In this place, the electrode of the right-hand was placed. The location of the second one was caudal to 1/3 of the jugular sulcus, where the left-hand electrode was placed. The third point was located in the area of the cow's withers, in place of which a neutral tap was fixed. Crocodile clamps were used to secure the electrodes. The teeth on the corresponding clamps were previously blunted to prevent injury to the animal. During the electrocardiographic study, the electrical potentials of the heart in cows were recorded by a galvanometer. Registration and recording of indicators were carried out using a stylus on cardiographic paper. The stylus moved according to changes in the electrical potentials of the heart, which was recorded by the galvanometer. The speed of the tape movement during the recording of cardiac signals was 50 mm/s. The results obtained were calculated using the Microsoft Excel software suite.

The following indicators were determined based on the results of the variability-pulse oximetry study: mode (Mo) – heart rate at the R-R interval among the calculated 100 measurements, which is the most frequent, i.e., a cardiac signal that regularly repeats on the cardiogram; mode amplitude (AMo) – value of the mode indicator in percent, namely the percentage ratio of the mode to the total number of cardiac intervals; variation range (Δx) – difference between the maximum and minimum mode indicators; autonomic balance index (ABI) – value that corresponds to the influence of the parasympathetic or sympathetic nervous system on the animal's body and indicates the degree of action of these departments, calculated when determining the difference in mode amplitude with a variation range; autonomic rhythm index (ARI) – reflects the action of the sympathetic nervous system in the animal's body and is determined by Equation 1:

$$ARI = 1 \div (Mo \times \Delta x). \quad (1)$$

Stress index – (SI) – indicator that characterises the tension of the animal's body, that is, its stressful state, and the obtained values reflect the state of the autonomic nervous system tone, calculated by the equation:

$$SI = AMo \div (2 \times Mo \times \Delta x). \quad (2)$$

According to the results of the processed indicators, three experimental groups of cows were formed from 100 animals in accordance with the tone of the autonomic nervous system. The main indicator by which the grouping of experimental groups of cows took place was the stress index, which reflected the state of sympathovagal balance in their body. Animals that showed low values of this indicator based on the results of calculations were classified as vagotonics, with high characteristics – as sympathotonics, and with intermediate values – as normotonics. 5 animals were selected from each group of cows to clarify the features of the autonomic nervous system tone. Thus, cows were divided into three experimental groups: normotonics, vagotonics, and sympathotonics. Blood was collected in sterile syringes in compliance with the rules of asepsis and antiseptics. The content of lipoproteins in blood plasma was determined using a Sinnova BS-3000 biochemical analyser (China), according to the instructions. To confirm the reliability of the results obtained, they were processed using variation statistics. Probable differences in values were determined by the Student's t-test. Designations that reflected the likely differences between the obtained indicators were reflected in the form: $P<0.05$, $P<0.01$, $P<0.001$.

Information on compliance with bioethical standards. The study met ARRIVE's recommendations and was conducted without violating the guidelines of Directive 2010/63/EU of the

European Parliament and of the council "On the Protection of Animals Used for Scientific Purposes" (2010).

Results and Discussion

Based on the results of the analysis of the obtained lipidogram, it should be noted that the obtained values of the studied indicators corresponded to the limits of physiological parameters. If necessary, the body of these cows had sufficient reserves of neutral lipids to maintain the proper level of energy balance and, thereby, ensure the effective functioning of internal organs and tissues. During a biochemical study of the blood plasma of cows of the Ukrainian Black-and-White breed, cholesterol content and lipoprotein concentrations of different densities were obtained (Table 1).

Table 1. Indicators of cholesterol and lipoprotein content of different densities depending on the tone of autonomic nervous regulation (M±m; n=5)

Lipids	Normotonic	Sympathotonic	Vagotonic
Cholesterol, mmol/L	3.50±0.01	3.30±0.05**	3.81±0.02***
HDL, mmol/L	3.03±0.04	2.74±0.05**	3.21±0.04*
LDL, mmol/L	0.39±0.02	0.47±0.02*	0.54±0.03**
VLDL, mmol/L	0.06±0.01	0.09±0.01	0.06±0.01

Notes: *HDL – high-density lipoproteins; LDL – low-density lipoproteins; VLDL – very low-density lipoproteins*
**P<0.05, **P<0.01, ***P<0.001 – relative to the data of the normotonic group*
Source*: developed by the authors*

According to the results obtained, total cholesterol in vagotonic cows was the highest (by 8.85%), and sympathotonics had the lowest content (by 6%), compared to other groups of animals (P<0.01; P<0.001). Normotonics took an average value among the study groups, respectively. Such indicators indicate that sympathotonics have an increased intake of lipids by the body, which is reflected in lower cholesterol values in the blood. This may be conditioned by the fact that animals with a preference for the influence of the sympathetic nervous system in the body are more likely to be exposed to environmental factors. Increased tone of the sympathetic branch of the autonomic nervous system can contribute to an increase in total cholesterol levels in the blood of cows by several mechanisms. The sympathetic branch of the autonomic nervous system stimulates the production of glucocorticosteroids, such as cortisol, which increase blood cholesterol levels. A high tone of the sympathetic branch of the autonomic nervous system can contribute to a violation of lipid metabolism in the body, which also provokes an increase in cholesterol levels in the blood and the mobilisation of fatty acids from fat cells.

In turn, the animal actively uses the body's reserves, which contributes to the processes of lipolysis. Given this, with greater activity of the cardiovascular system, at the same time, the intensity of metabolic processes in the body will increase. Increased activity of the cardiovascular system provides an increase in the supply of oxygen and other nutrients to cells, which leads to increased metabolism and increased consumption of lipids as an energy source. The animal's body increases the production of glucose, which can lead to an increase in the synthesis of triglycerides and total cholesterol. As a result, the course of catabolic reactions will increase to maintain energy balance. An excessive

increase in total cholesterol can cause various negative consequences, for example, the development of atherosclerosis. When analysing the established dynamics relative to total cholesterol in the blood, vagotonics were characterised by high indicators. This is conditioned by the fact that the advantage of the parasympathetic nervous system in such cows showed a positive effect on the intensity of lipogenesis in their body. Studies show that activation of the parasympathetic nervous system leads to a decrease in blood glucose levels and the synthesis of triglycerides, which can positively affect the weight gain of animals and their productivity.

It is also worth noting that activation of the parasympathetic nervous system can reduce the production of glucocorticoids, which specifically affect lipid metabolism. Thus, increased parasympathetic nervous system tone can have a positive effect on lipid metabolism and the overall health of cows. In accordance with this, the graph shows high cholesterol levels within the physiological norm (Fig. 1).

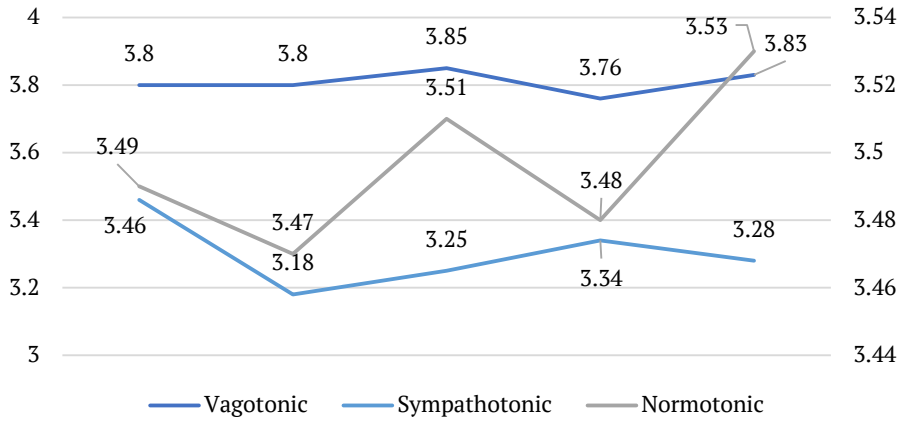

Figure 1. Total cholesterol content in the blood of cows of experimental groups, mmol/L
***Source**: developed by the authors*

The HDL content in the blood of animals among the experimental groups was 6% higher in vagotonics than in others, and 9.6% lower in sympathotonics ($P<0.05$; $P<0.01$). Normotonics had average scores compared to cows in the other two groups. According to them, vagotonics have higher HDL levels compared to sympathotonics. High-density lipoproteins can reduce the risk of heart disease by transporting cholesterol from the tissues to the liver for further conversion. Therefore, higher HDL levels in vagotonics may indicate a lower risk of cardiovascular disease compared to sympathotonics. Animals with a sympathovagal balance, where sympathotonia processes predominate, respectively, have a lower content of free fatty acids in the body. In turn, the need for more transport lipoproteins in the bloodstream is not so high, which could affect the HDL content. In addition, animals that are less exposed to stress factors have significantly smaller shifts in body homeostasis. Based on this, the experimental group of sympathotonics showed high activity of the cardiovascular system, which became the basis for the active course of lipolysis processes. These processes often occur under the influence of various factors, including changes in climatic conditions at different times of the

year. Depending on the tone of autonomic nervous regulation, the acceleration of metabolic processes occurs at different rates and duration. The autonomic nervous system can affect the speed and duration of metabolic processes in the body, depending on its tone. For example, activating the sympathetic branch of the autonomic nervous system can stimulate metabolism and reduce energy storage in tissues, which can lead to a rapid decrease in blood glucose levels. Activation of the sympathetic branch of the autonomic nervous system can lead to the release of norepinephrine and other catecholamines that stimulate metabolism in tissues, in particular, mobilise fats from complex organic compounds for use as an energy source. This can lead to a decrease in energy storage in the tissues and a rapid decrease in blood glucose levels.

Due to the influence of the tone of autonomic nervous regulation on the processes of lipoprotein metabolism, individual characteristics in the parameters of homeostasis were noted in experimental groups of animals, which is reflected in the HDL content in Figure 2. High HDL values obtained as a result of the study may indicate pathological changes in the body of cows, but considering the fact that sampling was carried out during lactation of cows, these changes could have an adaptive character and be regarded as physiological.

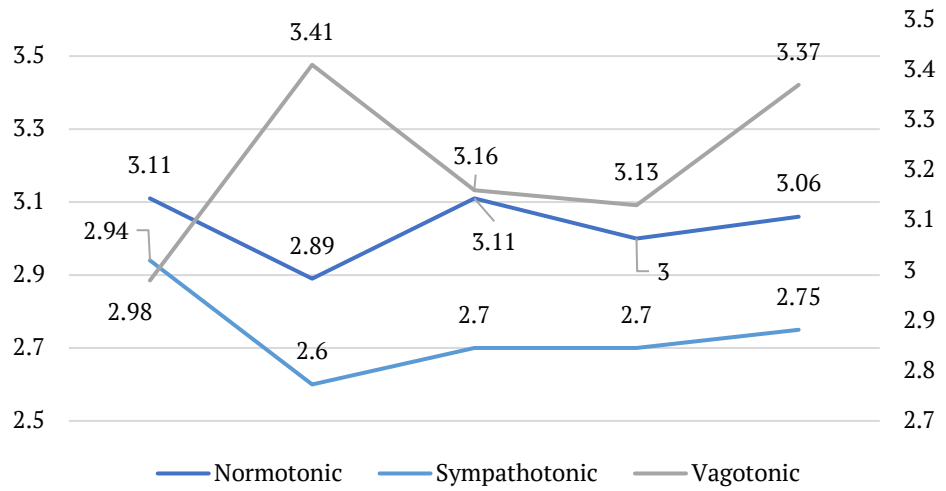

Figure 2. High-density lipoprotein content in cows of experimental groups, mmol/L
***Source**: developed by the authors*

Regarding LDL, among the animals of the experimental groups, the lowest content was observed in normotonics. This indicator is 21% less than that of sympathotonics and 38% less than that of vagotonics ($P<0.05$; $P<0.01$). Low LDL levels in experimental groups of animals are explained by the lactation period. Normally, cattle have a much higher LDL than HDL content in their blood. During lactation, an increase in the amount of HDL and a decrease in LDL were noted in the bloodstream due to active processes of milk formation in the mammary gland. During lactation, the LDL content in the blood decreases in cows, and HDL increases. This is conditioned by the fact that during lactation, cows produce more milk, which contains a significant amount of fat. To transport fat to the mammary glands, the cow's body produces

more HDL, which can transport fat to the mammary glands. In addition, during lactation, the synthesis of proteins and glucose increases, which contribute to an increase in HDL in the blood. Accordingly, the level of lipids increases, and as a result, the need for HDL synthesis increases, especially for cholesterol transport. In this regard, the quantitative indicators of LDL decrease, which is shown in Figure 3. Among the results obtained for VLDL, there were no significant differences between the animals of the experimental groups.

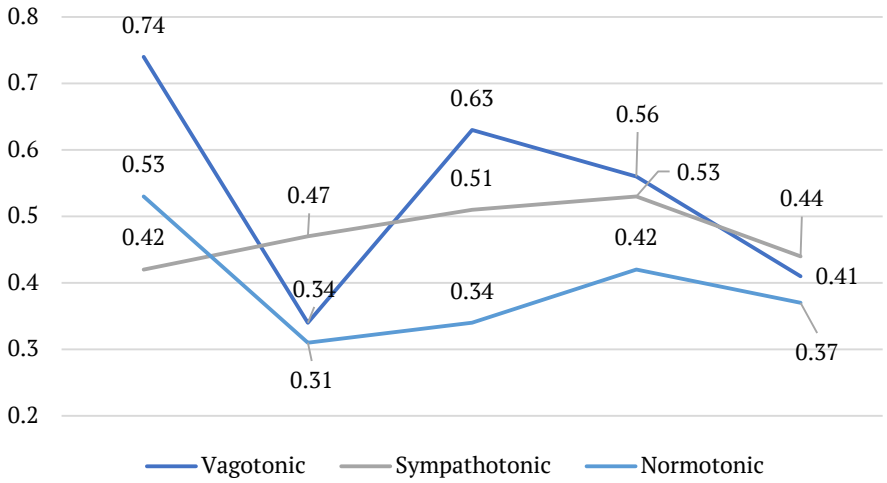

Figure 3. Low-density lipoprotein content in cows of experimental groups, mmol/L

***Source**: developed by the authors*

When analysing the results obtained, it should be noted that the influence of the autonomic nervous system tone on lipid content in cows has been studied in more detail by other researchers. Vagotonics may experience a decrease in high-density lipoprotein (HDL) levels and an increase in low-density lipoprotein (LDL) levels. This may be due to a decrease in the activity of enzymes responsible for HDL synthesis and removal, and, conversely, to an increase in the activity of enzymes responsible for LDL synthesis and removal. In addition, there may be a decrease in the intensity of lipid metabolism and an increase in their storage in the form of triglycerides, which can lead to weight gain and the development of obesity. Lipid homeostasis in sympathicotonics may be impaired due to increased activation of the sympathetic branch of the autonomic nervous system. This can lead to an increase in total cholesterol and triglycerides in the blood, a decrease in HDL levels, and an increase in LDL. There is also an increase in lipogenesis activity and a decrease in lipolysis, which contributes to the accumulation of lipids in the body. Cholesterol is an important component of cell membranes and performs a variety of biological functions. It is a precursor for the synthesis of steroids, bile acids, and vitamin D, affects the functioning of the cardiovascular system, in particular, vascular permeability, as well as anti-inflammatory and immunomodulatory processes. However, high blood cholesterol levels may be associated with the risk of developing cardiovascular diseases and other pathologies.

Among the studies, general issues related to the consideration of the participation of the autonomic nervous system on these indicators under different conditions or the use of different feed additives are considered (Yu *et al.,* 2021; Yang *et al.,* 2022b). These papers do not consider the individual characteristics of the animal when describing the autonomic nervous system as an indicator that is important in the development of stable homeostasis of the animal's body. Accordingly, significant or minor changes in the lipidogram are often described under the influence of artificially created stressors or changes in diet (Eder *et al.,* 2021; Ma *et al.,* 2023). There are significant discrepancies when comparing the experimental and control groups, some indicators do not differ or even have significant differences that do not give a clear answer to the question posed (Sammad *et al.,* 2020; Myers *et al.,* 2021*)*. Considering the results obtained, it should be noted that in some researchers, the indicators of high-density lipoproteins were lower compared to low-density lipoproteins (Gonçalinho *et al.,* 2021). This feature is explained by the fact that depending on the period, for example, HDL indicators may increase before calving, which is physiologically normal. High levels of high-density lipoproteins in cows are indicated by T. Takahashi *et al.* (2021), which confirms the reliability of the study and compliance with the physiological norm of the results obtained. Regarding the effect of the autonomic nervous system on lipid metabolism in the body, Y. Liu *et al.* (2020) provide a relevant example regarding the role of the sympathetic nervous system in lipid oxidation. The researchers noted that with the participation of neurohumoral effects on the body, metabolic processes can accelerate or slow down. In stressful situations, the sympathetic branch of the autonomic nervous system is activated in the body, which can lead to an increase in glucose production in the liver and a decrease in glucose consumption by muscles. In addition, increased sympathetic branch tone can contribute to an increase in total cholesterol and low-density lipoproteins in the blood. They repeatedly involve the autonomic nervous system as a control factor. To better understand the need to investigate this issue, it should be noted that research is constantly being conducted to improve the productivity of the dairy herd. Increasing the productivity of a dairy herd is possible by improving the diet, which can affect the work of neurohumoral mechanisms of metabolic regulation, increasing the physical activity of animals, which can cause activation of the sympathetic branch of the autonomic nervous system and contribute to an increase in metabolic processes in the body. On the example of the studies by A. Razzaghi *et al.* (2022) and G.H.F. Gonçalinho *et al.* (2021), the areas of improving the nutritional value of feed and increasing new feed additives are actively developing to obtain a larger volume of quality products. Most processes are tied to the consideration of many factors. The effect of stress on the animal is currently quite significant. Regardless of the aetiology, any negative impact on the cow can affect its productivity. Accordingly, depending on the individual characteristics of each animal, the response to the stress factor may vary. In the future, the recovery period for normal performance will increase significantly. I.C. Okuyucu *et al.* (2023) note that many factors, such as physiological, biochemical, and behavioural mechanisms, must be taken into account.

After analysing the results obtained, it should be noted that lipid metabolism may differ depending on the tone of the autonomic nervous system. On the example of an experimental group of sympathotonics, animals in which the influence of the sympathetic nervous system prevailed had low cholesterol levels. Thus, a decrease in the level of lipids in the

blood may indicate the activity of lipolysis processes in the animal's body, which may be associated with an increased energy demand of the body or with an increased tone of the sympathetic branch of the autonomic nervous system. Such processes can help ensure the constancy of lipid homeostasis in the animal's body. The system of lipid homeostasis in animals includes a variety of processes that ensure the preservation of constant levels of lipids in the body. This is achieved through various mechanisms that ensure the production, transport, and use of lipids in the body's cells and tissues. One of these mechanisms is related to the level of lipoproteins of different densities, which transport lipids in the blood. A decrease in lipoprotein levels may indicate that the animal's body consumes lipids to ensure constant homeostasis.

Conclusions

As a result of the conducted studies, it was found that the tone of the autonomic nervous system affects the cholesterol content in the blood of cows of the Ukrainian Black-and-White breed. This is because the sympathetic branch causes changes in the functioning of the liver, which regulates glucose production in the body, and this can lead to increased cholesterol synthesis. In addition, increased sympathetic branch tone can promote the activation of enzymes responsible for cholesterol synthesis and reduce the level of hormones that regulate its synthesis and transport in the body. Among the experimental groups of animals, there is an increase in lipid indicators in vagotonics and a decrease in sympathotonics. This indicates the dependence of the quantitative parameters of lipoproteins and total cholesterol in the blood on the tone of the autonomic nervous system. Normotonics, which are characterised by equilibrium in the sympathovagal balance, occupied an intermediate place in relation to the studied parameters in comparison with animals with a predominant tone of the sympathetic or parasympathetic branches of the autonomic nervous system. This means that normotonics can have certain advantages over animals with an imbalance of the autonomic nervous system, as they are characterised by greater flexibility in responding to changes in the internal and external environment, which can have a positive impact on their health and productivity.

Each animal is special, and its response to the state of sympathovagal balance can be individual. Therefore, to ensure an optimal level of lipid metabolism intensity in the body of productive animals, it is necessary to conduct an individual assessment of the tone of the autonomic nervous system and consider other factors that affect their health and productivity level. Consideration of the results obtained will allow systematically influencing the improvement of consumption and efficiency of assimilation of feed nutrients by animals to obtain the desired productivity. In the future, it is planned to investigate the effect of the tone of the autonomic nervous system on lipid homeostasis in the body of cows depending on the time of year.

Acknowledgements

None.

Conflict of Interest

None.

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Вплив тонусу автономної нервової системи на вміст холестерину та ліпопротеїнів різної щільності в крові корів

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Анотація. Актуальність даної теми полягає у вивченні впливу тонусу автономної нервової системи на вміст ліпідів в організмі корів, що важливо враховувати для забезпечення високої продуктивності дійного стада та збалансування раціонів у годівлі тварин. Мета роботи полягала у визначенні впливу тонусу гангліорнарної нервової системи на вміст холестерину та ліпопротеїнів різної щільності у крові молочних корів української чорно-рябої породи. Для дослідження варіабельності серцевого ритму використовували електрокардіограф із подальшим вимірюванням основних показників за методикою Баєвського, що включало визначення моди, її амплітуди, варіаційний розмах, індекс автономної рівноваги, автономний показник ритму та індекс напруги. З піддослідних корів були сформовані три дослідні групи: нормотоніки, ваготоніки та симпатотоніки. Вміст ліпопротеїнів у плазмі крові визначали за допомогою біохімічного аналізатора Sinnova BS-3000 (Китай). За результатами біохімічного аналізу встановлено відмінності в отриманих показниках серед дослідних груп корів із різним тонусом автономної нервової системи. Це пов'язано

з тим, що активізація симпатичної нервової гілки призводить до змін у роботі печінки, яка впливає на вироблення глюкози в організмі. Це може призвести до збільшення вироблення холестерину. Крім того, підвищений тонус симпатичної гілки може стимулювати активність ферментів, що відповідають за формування холестерину, та призвести до зниження рівня гормонів, які регулюють його утворення та транспортування в організмі. Зокрема, у тварин ваготоніків відзначали найбільший вміст у крові загального холестерину та ліпопротеїнів високої щільності. У симпатотоніків виявляли найменші значення в крові вмісту загального холестерину та ліпопротеїнів високої щільності. Нормотоніки займали проміжне місце серед дослідних груп корів. Детальне вивчення цього питання розкриває особливості впливу тонусу автономної нервової системи на показники обміну ліпідів у крові корів, що важливо враховувати на виробництві для ефективного вирішення питань зі збереження їх продуктивності та покращення якісних показників молока

Ключові слова: гангліонарна нервова система; нормотоніки; ваготоніки; симпатотоніки; ліпіди; українська чорно-ряба