ANIMAL SCIENCE AND FOOD TECHNOLOGY

Journal homepage: https://animalscience.com.ua/en
Animal Science and Food Technology, 15(4), 49-63
Received 09.07.2024 Revised 02.11.2024 Accepted 27.11.2024

UDC 636.2.034:637.12.043
DOI: 10.31548/animal.4.2024.49

Changes in unsaturated fatty acids in milk under vegetative regulation in dairy cattle

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Abstract. The fatty acid content of milk serves as a reliable indicator of its quality. Changes in this parameter depend on various factors, which must be considered when implementing methods to adjust the fatty acid composition of milk. This study aimed to determine the influence of the autonomic nervous system in dairy cows on the fatty acid composition of milk. The research was

Suggested Citation:
Zhurenko, O., Hryshchuk, I., Kryvoruchko, D., & Zhurenko, V. (2024). Changes in unsaturated fatty acids in milk under vegetative regulation in dairy cattle. *Animal Science and Food Technology*, 15(4), 49-63. doi: 10.31548/animal.4.2024.49.

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conducted on Ukrainian Black-and-White dairy cows. Experimental groups were formed using electrocardiography to establish the tone of the autonomic nervous system. Fatty acid analysis was performed via gas chromatography, with lipid extraction conducted using the Folch method. It was observed that the proportion of myristoleic acid in the experimental group of vagotonic cows was 6.9% higher than that of normotonic cows ($P < 0.05$). The content of palmitoleic acid in the milk of vagotonic cows, according to chromatographic analysis, was 11.6% higher ($P < 0.01$) and in sympathotonic cows 5.8% higher ($P < 0.05$) compared to normotonic cows. The oleic acid content in the milk of vagotonic cows was 4.2% higher ($P < 0.01$) and in sympathotonic cows 1% higher ($P < 0.05$) compared to normotonic cows. The linoleic acid content in the milk of vagotonic cows was 6.1% higher ($P < 0.001$) and in sympathotonic cows 31.7% higher ($P < 0.001$) than that of normotonic cows. Conversely, the α-linolenic acid content in vagotonic cows was 38.5% lower ($P < 0.01$) and in sympathotonic cows 34.6% lower ($P < 0.01$) than in normotonic cows. These findings indicated that the experimental group of normotonic cows had the lowest levels of unsaturated fatty acids in milk

Keywords: ruminants; lipids; chromatography; cow's milk; milk production

Introduction

Quality control of dairy products is a priority for every farm because, according to G. Gużewska *et al.* (2024), maintaining stable and high profits depends significantly on qualitative and quantitative indicators. Timely identification of changes in milk's constituent elements and making appropriate adjustments prevents considerable economic losses, as milk is produced daily on dairy farms. For the production of milk and dairy products, raw materials must be of high quality, assessed through various technological processes, including chemical and physicochemical factors, such as the fatty acid profile, fat content, protein-to-fat ratio, urea content, acidity, dry matter content, and evaluation of milk fat globules by size and density. One of the most common methods for assessing product quality is determining fatty acid composition via chromatography (Wu *et al.*, 2023).

Modern milk production increasingly focuses on optimising initial milk quality indicators rather than merely increasing total volume and fat content, though these remain relevant objectives. According to M. Salvian *et al.* (2023), the trend in dairy production is shifting away from considering milk weight alone and towards a more detailed emphasis on gross energy value. This approach enables a better assessment of product quality, particularly for raw materials sourced from other countries. Since each country has distinct native breeds and variations in feed and pasture conditions, the effective evaluation of dairy products should be based on comprehensive data (Ali *et al.*, 2023).

Various feed additives are used to improve the quality of the final product, and they exhibit a measurable degree of effectiveness. Improving the fatty acid composition of milk is among the primary objectives, with particular emphasis often placed on unsaturated fatty acids due to their beneficial impact on energy balance and their role in lipid metabolism regulation. It should be noted that the concentration of unsaturated and saturated fatty acids in milk may change during technological processing. According to R. Fan *et al.* (2023), heat treatment processes for milk, including pasteurisation and ultra-high temperature treatment, significantly affect its nutritional components. Studies of milk and dairy products subjected to heat treatment revealed a tendency for an increase in saturated fatty acids. When exposed to high temperatures, the ratio of long-chain fatty acids decreased, while the proportion of medium-chain fatty acids increased. These changes in the fatty acid composition of milk and dairy products underscore the need to develop strategies for enhancing the content of unsaturated fatty acids to improve the nutritional value of raw materials after heat treatment. When examining methods for correcting lipid metabolism, factors regulating these processes must be considered. One example is the autonomic nervous system, which plays a crucial role in maintaining homeostasis within the body.

The study of mechanisms to improve metabolic processes in cows has the potential to significantly increase livestock productivity and enhance product quality to meet consumer demands. Moreover, research into the mechanisms underlying the regulation of metabolic processes will support the development of more effective solutions to challenges encountered in production.

Literature Review

Y. Gao *et al.* (2024) note that milk is an essential component of the daily diet due to the presence of over ten major nutritional components, including protein, lipids, vitamins, and minerals. Depending on the type of animal, the composition of milk and the ratio of key components vary. The presence of these essential nutritional components ensures optimal development of systems such as the nervous and immune systems, which significantly enhance the value of dairy products. D. Brozić *et al.* (2024) emphasised that achieving high productivity in a dairy herd and ensuring the production of quality raw materials require active attention to animal development, even during the foetal stage. Well-developed livestock will ensure a steady supply of high-quality products, ultimately increasing farm profitability. Balanced nutrition for cows during pregnancy, including the mandatory inclusion of high levels of fatty acids, improves the development and formation of the foetus, particularly the central nervous and immune systems. Additionally, it should be noted that after calving, the cow's body must contain sufficient highenergy compounds such as lipids to supply the newborn with adequate energy.

During the cow's growth and development, it is essential to balance lipid intake in the diet because hormonal and metabolic changes can lead to oxidative stress or significant mobilisation of body reserves, which, according to X. Sun *et al.* (2023), can impair lactogenesis and reduce productivity. To address this issue, various nutritional supplements based on unsaturated fatty acids or probiotics are frequently used to enhance rumen digestion. L. Phuoc Thanh *et al.* (2023) found that feed additives containing substantial amounts of polyunsaturated fatty acids resulted in a reduction in saturated fatty acids compared to the control group. Additionally, a decrease in the atherogenicity and thrombogenicity indices was observed. Overall, the total concentration of volatile fatty acids in the rumen decreased, leading to improved initial milk quality.

N. Urrutia *et al.* (2023) and A. Mohammed *et al.* (2024) investigated the use of dietary fatty acid supplements, specifically those with a high concentration of omega-3 polyunsaturated fatty acids, by incorporating flaxseed into the feed. According to the initial results of lipid metabolism studies, the levels of fatty acids in the blood showed significant improvement, and an enhancement in rumen digestion was also observed. Chromatographic analysis of the fatty acid composition of lipids revealed a reduction in the omega-6 to omega-3 fatty acid ratio. In terms of total fatty acid concentration, a significant decrease in both short-chain and long-chain saturated fatty acids was observed. Moreover, an increase in milk production was reported in cows consuming feed enriched with polyunsaturated fatty acids.

In the study of metabolic processes, in addition to examining the organic substances that contribute to overall homeostasis, attention is often directed towards the systems that regulate these processes. A. Furlan & P. Petrus (2023) highlighted an important mechanism within organised biological systems: the connection between the brain and the body in regulating metabolic processes. It has been established that any process in a living organism is influenced by corrective systems, with the neurohumoral system playing a central role. This system encompasses a multifaceted network of components that process, analyse, and regulate numerous interrelated physiological processes. One component frequently emphasised concerning homeostasis regulation is the autonomic nervous system. This system, with its subdivisions – the sympathetic and parasympathetic nervous systems – controls processes such as digestion and the fundamental mechanisms of nutrient synthesis and breakdown. G. Mishra & K.L. Townsend (2023) emphasised the close relationship between the autonomic nervous system and lipid metabolism. They noted that as a result of the direct influence of this nervous system on nutrient synthesis and resynthesis, the sympathetic nervous system mobilises lipids from adipose tissue when energy-rich substances are required. This process is exemplified by the body's response to stress factors.

Materials and Methods

The research was conducted on the dairy farm of Obriy LLC from 2023 to 2024, involving five cows of the Ukrainian Black-and-White dairy breed in a single experimental group. Experimental groups of animals were formed using a variational pulse oscillometric study based on the Baevsky method, employing a Heart Mirror IKO electrocardiograph (Hungary, Innomed). Based on the electrocardiogram results, the following indicators were determined: heart rate interval between R-R segments on the recorded tape, expressed in mode (Mo). The percentage value of the mode indicator, representing the most frequent occurrence in a segment of 100 heartbeats, was calculated and reflected as the mode amplitude (AMo). The difference between the maximum and minimum mode values at selected points, corresponding to the variation range (Δx), was also determined. Subsequently, key values were calculated: the autonomic balance index (ABI), which represents the difference between the mode amplitude and the variation range and characterises the influence of the sympathetic and parasympathetic nervous systems; the autonomic rhythm index (ARI), which reflects the influence of the sympathetic nervous system, was calculated using equation (1):

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

The stress index (SI), representing the animal's stress state and characterising the tension of the autonomic nervous system, was determined using equation (2):

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

The statistical analysis of the initial parameters of the variability-pulse study identified the tone of the autonomic nervous system, which corresponded to normotonia, vagotonia, and sympathotonia tones of the autonomic nervous system. Based on the obtained individual characteristics of autonomic regulation, three experimental groups were formed: normotonics, vagotonics, and sympathotonics. Blood samples were collected in the morning, four hours after feeding, in compliance with aseptic and antiseptic procedures. Samples were taken from the jugular vein using a sterile syringe containing heparin. A heparin solution was prepared in a proportion of 3 drops of 1% heparin per 10 mL of blood. The samples were transported in a thermocontainer maintained at a temperature of +4°C. Blood plasma was separated by centrifugation at 2,000 rpm for 10 minutes.

The preparation of blood plasma for the analysis of the fatty acid composition of milk via gas chromatography was performed according to the Folch method. Centrifuged blood plasma was transferred into a flask with a lapped lid, followed by the gradual addition of methanol and chloroform in a ratio of 2:1. The volume of these solutions was adjusted to the raw material under study at a ratio of 1:20. The flask was thoroughly shaken and left for 12 hours to allow extraction. After this period, the contents of the flask were filtered through filter paper. To the filtrate, 0.74% KCl was added at a ratio of 1:5 relative to the solution. After standing for 12 hours, the solution separated into two layers, with the lower layer consisting of chloroform containing dissolved lipids. The lower layer was removed, and the extracted lipids were obtained using a reflux evaporator (Folch *et al.*, 1957).

The chromatographic analysis was conducted using a Trace GC Ultra chromatograph (USA) equipped with a flame ionisation detector. The samples were chromatographed under the following conditions: detector temperature of +260°C and column temperature ranging from +140°C to +240°C. A sample of the test material was introduced into the chromatograph using a TriPlus autosampler, with an injection volume of 1 µL. The analysis time for each test sample was approximately 65 minutes. Peaks on the chromatogram were evaluated relative to the standard sample, Supelco 37 Component FAME Mix (USA). Statistical processing of the obtained data was performed using Microsoft Excel, with the significance of differences in evaluation indicators assessed via Student's t-test at $P < 0.05$, $P < 0.01$, and $P < 0.001$ levels.

All manipulations involving cattle during the experimental studies presented in this research adhered to the fundamental principles of bioethics, in compliance with Article 26 of the Law of Ukraine "On the Protection of Animals from Cruelty" (2006), the European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes (1986), and the "General Ethical Principles for Animal Experiments" adopted by the First National Congress on Bioethics (Procedure for conducting..., 2012).

Results and Discussion

According to the results of the chromatographic analysis of milk from the experimental group of sympathotonics, the following unsaturated fatty acids were identified: myristoleic, palmitoleic, oleic, linoleic, and α-linolenic acids (Table 1).

***Table 1.** Statistical analysis of unsaturated fatty acids in milk from cows with normotonia*

Indicators	NVO	SE	M	SD	A	Min	Max
C14:1 Myristoleic acid	5	0.02	1.31	0.05	0.74	1.26	1.38
C16:1 Palmitoleic acid	5	0.02	1.55	0.05	-0.39	1.47	1.61
C18:1n9c Oleic acid	5	0.03	22.75	0.07	-0.52	22.65	22.84
C18:2n6c Linoleic acid	5	0.01	3.12	0.02	-0.21	3.09	3.15
C18:3n3 α-linolenic acid	5	0.01	0.26	0.03	-0.61	0.21	0.29

Notes: NVO – number of valid observations, SE – standard error, M – mean value, SD – standard deviation, A – asymmetry, Min – minimum value, Max – maximum value
Source: authors' development

After processing the chromatogram, it was found that the content of myristoleic acid ranged from 1.26% to 1.38%, with an average of 1.31 ± 0.02%. Myristoleic acid in the experimental group of cows with a balanced sympatho-vagal balance exhibited a difference of 0.12% between the maximum and minimum values, indicating a slight variation in the initial results of the experimental group. The percentage of palmitoleic acid ranged from

1.47% to 1.61%, with an average of 1.55 ± 0.02%. Palmitoleic acid in the experimental group of cows with a balanced sympatho-vagal balance exhibited a difference of 0.14% between the maximum and minimum values, again reflecting slight variation in the initial results. The percentage of oleic acid ranged from 22.65% to 22.84%, with an average of 22.75 ± 0.03%. Oleic acid in the experimental group of cows with a balanced sympatho-vagal balance showed a difference of 0.19% between the maximum and minimum values, indicating minimal variation. The percentage of linoleic acid ranged from 3.09% to 3.15%, with an average of 3.12 ± 0.02%. Linoleic acid in the experimental group of cows with a balanced sympatho-vagal balance exhibited a difference of 0.06%, reflecting slight variation. Finally, the percentage of α-linolenic acid ranged from 0.21% to 0.29%, with an average of 0.26 ± 0.02%. α-linolenic acid in the experimental group of cows with a balanced sympatho-vagal balance showed a difference of 0.06%, indicating minimal variation in the initial results.

According to the results of chromatographic studies of milk from cows with sympathotonia, the following unsaturated fatty acids were identified: myristoleic, palmitoleic, oleic, α-linolenic, and linoleic acids (Table 2).

Table 2. *Statistical analysis of unsaturated fatty acids in milk from cows with sympathotonia*

Indicators	NVO	SE	M	SD	A	Min	Max
C14:1 Myristoleic acid	5	0.04	1.27	0.08	-0.94	1.14	1.36
C16:1 Palmitoleic acid	5	0.03	1.64	0.06	0.35	1.57	1.72
C18:1n9c Oleic acid	5	0.03	22.89	0.08	-0.71	22.78	22.98
C18:2n6c Linoleic acid	5	0.04	4.11	0.10	1.53	4.03	4.28
C18:3n3 α-linolenic acid	5	0.01	0.17	0.03	-0.69	0.12	0.21

Notes: NVO – number of valid observations, SE – standard error, M – mean value, SD – standard deviation, A – asymmetry, Min – minimum value, Max – maximum value
Source: authors' development

After processing the chromatogram, it was found that the content of myristoleic acid ranged from 1.14% to 1.36%, with an average of 1.27 ± 0.04%. Myristoleic acid in the experimental group of cows with sympathotonia exhibited a difference of 0.22% between the maximum and minimum values, which indicated a slight variation in the initial results of the experimental group. The percentage of palmitoleic acid ranged from 1.57% to 1.72%, with an average of 1.64 ± 0.03%. Palmitoleic acid in the experimental group of cows with sympathotonia exhibited a difference of 0.15%, reflecting a slight variation in the initial results. The percentage of oleic acid ranged from 22.78% to 22.98%, with an average of 22.89 ± 0.03%. Oleic acid in the experimental group of cows with sympathotonia exhibited a difference of 0.20%, indicating minimal variation. The percentage of linoleic acid ranged from 4.03% to 4.28%, with an average of 4.11 ± 0.04%. Linoleic acid in the experimental group of cows with sympathotonia exhibited a difference of 0.25%, indicating slight variation. Finally, the percentage of α-linolenic acid ranged from 0.12% to 0.21%, with an average of 0.17 ± 0.01%. α-linolenic acid in the experimental group of cows with sympathotonia exhibited a difference of 0.09%, indicating minimal variation in the initial results.

According to the results of the chromatographic study of milk from the experimental group of vagotonics, the following unsaturated fatty acids were identified: myristoleic, palmitoleic, oleic, linoleic, and α-linolenic acids (Table 3).

Table 3. *Statistical analysis of unsaturated fatty acids in milk from cows with vagotonia*

Indicators	NVO	SE	M	SD	A	Min	Max
C14:1 Myristoleic acid	5	0.02	1.40	0.04	-0.03	1.35	1.44
C16:1 Palmitoleic acid	5	0.04	1.73	0.08	-0.58	1.64	1.80
C18:1n9c Oleic acid	5	0.03	23.71	0.06	0.09	23.64	23.79
C18:2n6c Linoleic acid	5	0.02	3.31	0.05	-0.40	3.24	3.37
C18:3n3 α-linolenic acid	5	0.01	0.16	0.02	-1.03	0.12	0.18

Notes: NVO – number of valid observations, SE – standard error, M – mean value, SD – standard deviation, A – asymmetry, Min – minimum value, Max – maximum value
Source: authors' development

After processing the chromatogram, it was found that the content of myristoleic acid ranged from 1.35% to 1.44%, with an average of 1.40 ± 0.02%. Myristoleic acid in the experimental group of cows with vagotonia exhibited a difference of 0.09% between the maximum and minimum values, which indicated a slight variation in the initial results of the experimental group. The percentage of palmitoleic acid ranged from 1.64% to 1.80%, with an average of 1.73 ± 0.04%. Palmitoleic acid in the experimental group of cows with vagotonia exhibited a difference of 0.16%, reflecting a slight variation in the initial results. The percentage of oleic acid ranged from 23.64% to 23.79%, with an average of 23.71 ± 0.03%. Oleic acid in the experimental group of cows with vagotonia exhibited a difference of 0.15%, indicating minimal variation. The percentage of linoleic acid ranged from 3.24% to 3.37%, with an average of 3.31 ± 0.02%. Linoleic acid in the experimental group of cows with vagotonia exhibited a difference of 0.13%, indicating slight variation. Finally, the percentage of α-linolenic acid ranged from 0.12% to 0.18%, with an average of 0.16 ± 0.01%. α-linolenic acid in the experimental group of cows with vagotonia exhibited a difference of 0.06%, indicating minimal variation in the initial results.

When assessing the fatty acid composition of milk from cows with varying autonomic regulation, it was found that the content of myristoleic acid in animals from the experimental group exhibiting a predominance of vagotonia was higher than in those with a predominance of normotonia by 6.9% ($P < 0.05$) (Fig. 1).

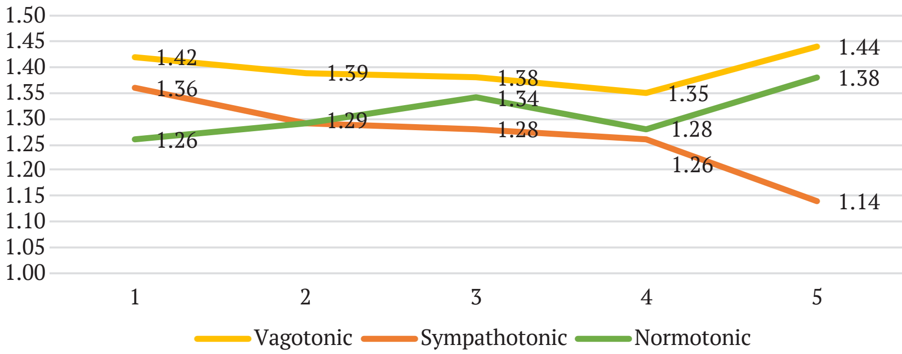

Figure 1. Percentage of myristoleic acid in cow's milk under different autonomic nervous system tones
Note: colours indicate different tones of the autonomic nervous system, respectively
Source: authors' development

When assessing the fatty acid composition of milk from cows with varying autonomic regulation, it was found that the content of palmitoleic acid in animals from the experimental group with a predominance of vagotonia was higher than in those with a predominance of normotonia by 11.6% (P < 0.01), and higher in animals with sympathotonia by 5.8% (P < 0.05) (Fig. 2).

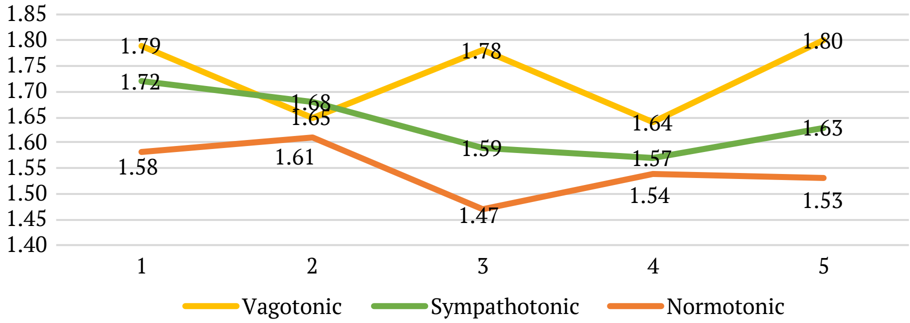

Figure 2. Percentage of palmitoleic acid in cow's milk under different autonomic nervous system tones

Note: colours indicate different tones of the autonomic nervous system, respectively

Source: authors' development

When assessing the fatty acid composition of milk from cows with varying autonomic regulation, it was found that the content of oleic acid in animals from the experimental group with a predominance of vagotonia was higher than in those with a predominance of normotonia by 4.2% (P < 0.01), and higher in animals with sympathotonia by 1% (P < 0.05) (Fig. 3).

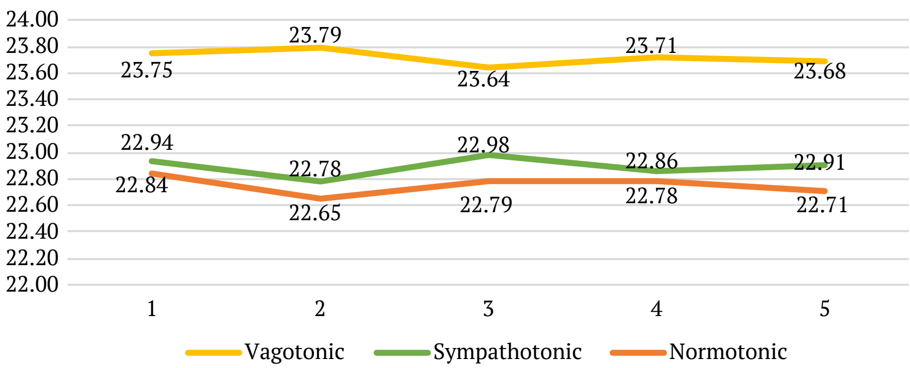

Figure 3. Percentage of oleic acid in cow's milk under different autonomic nervous system tones

Note: colours indicate different tones of the autonomic nervous system, respectively

Source: authors' development

When assessing the fatty acid composition of milk from cows with varying autonomic regulation, it was found that the content of linoleic acid in animals from the experimental group with a predominance of vagotonia was higher than in those with a predominance of normotonia by 6.1% (P < 0.001), and higher in animals with sympathotonia by 31.7% (P < 0.001) (Fig. 4).

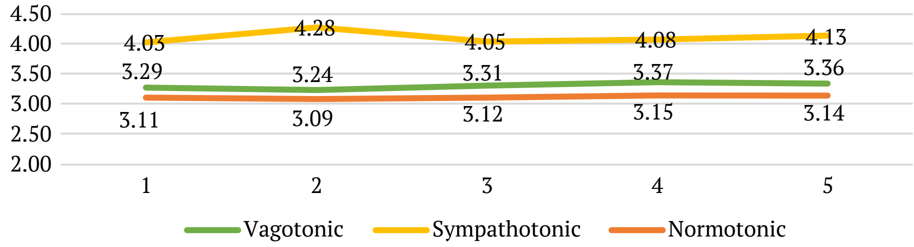

Figure 4. Percentage of linoleic acid in cow's milk under different autonomic nervous system tones

Note: colours indicate different tones of the autonomic nervous system, respectively

Source: authors' development

When assessing the fatty acid composition of milk from cows with varying autonomic regulation, it was found that the content of α-linolenic acid in animals from the experimental group with a predominance of vagotonia was higher than in those with a predominance of normotonia by 38.5% ($P < 0.01$), and higher in animals with sympathotonia by 34.6% ($P < 0.01$) (Fig. 5).

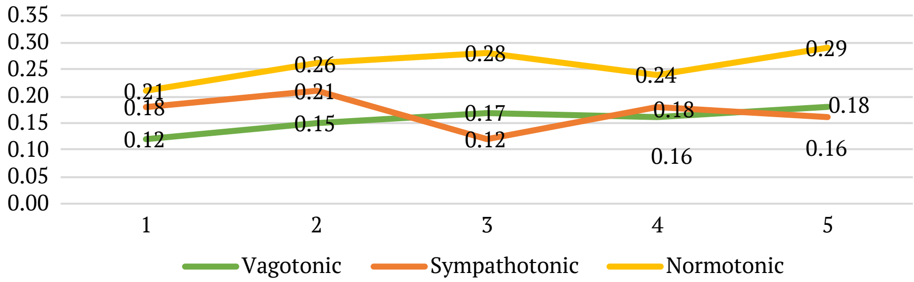

Figure 5. Percentage of α-linolenic acid in cow's milk under different autonomic nervous system tones

Note: colours indicate different tones of the autonomic nervous system, respectively

Source: authors' development

The milk fat profile is a crucial component in evaluating the quality of dairy products. Therefore, improving the composition of milk plays a key role in the management of dairy cattle. C. Loza *et al.* (2023) established that a significant percentage of the composition of milk fat depends on the level of fatty acid synthesis in the animal's body, which is significantly influenced by the feeding diet. To address the challenge of improving cow productivity and the quality of dairy products, various methods for modifying the fatty acid composition of milk through adjustments to the cows' feeding diet have been developed. S.B. Beyzi & C.Ç. Dallı (2023) formulated a cow feeding ration incorporating additives such as fish oil and microalgae. According to their results, there was an increase in the content of C16:0 and C18:1, alongside a decrease in the concentration of C18:0 ($P < 0.05$). However, there were no significant changes in the indicators of the fatty acid composition of milk, nor was there any effect on ruminal digestion parameters or blood cholesterol levels.

D. Rico *et al.* (2023) employed linseed oil to improve the fatty acid profile of milk and stabilise oxidative processes. The use of linseed oil at different dosages affected the levels of cis9, cis-12 linoleic acid and cis-9, cis-12, cis-15 α-linolenic acid, which increased proportionally to the amount of linseed oil added ($P < 0.01$). Notably, the concentrations of tetradecanoic and palmitic fatty acids decreased inversely. However, the increase in unsaturated fatty acids heightened the risk of oxidative processes in milk, which negatively impacts dairy producers. M. Neofytou *et al.* (2023) used olive oil production by-products, namely olive cake, to improve lipid metabolism in animals. The inclusion of this component had a positive effect on milk composition, as it led to an increase in monounsaturated fatty acids, proportional to the concentration of olive cake included. A decrease in saturated fatty acids from C4:0 to C16:0 was also observed. However, no changes were recorded in the total milk yield or milk fat and protein content.

R. Pierce *et al.* (2024) investigated the dietary supplementation of cottonseed in cows to improve milk yield and the fatty acid profile. Their research established that the addition of cottonseed to the diet of cows did not enhance milk fat content or improve milk productivity in multiparous cows. However, a significant increase was observed in first-lactation cows, reflected in a marked rise in milk fat proportional to the volume of the applied food supplement. A. Shazly *et al.* (2023) conducted a study on the use of food additives such as soybean oil, linseed oil, and their combination to regulate fatty acid metabolism in animals, subsequently influencing the lipid profile of milk. Their findings revealed that the content of unsaturated fatty acids, such as C18:1 and C18:2, increased, while the percentage of saturated fatty acids, including C4:0, C14:0, and C16:0, decreased. The study concluded that there was an improvement in the ratio of unsaturated to saturated fatty acids.

Despite the positive effects of vegetable-based food additives on the fatty acid composition of milk, it is worth noting that high levels of unsaturated fatty acids are not always advantageous for dairy products. The shelf life of milk is significantly shortened due to oxidative processes, negatively impacting farm productivity. Furthermore, when incorporating various nutritional supplements into the diet of high-yielding cows, the role of the rumen microbiota must be considered, as highlighted by L. Coates *et al.* (2023). According to H. Hou *et al.* (2023) and W. Lou *et al.* (2024), it is essential to consider the predictive modelling of the fatty acid composition of milk to enhance the effectiveness of methods aimed at improving lipid metabolism in animals. The authors emphasise that successful predictions of fatty acid metabolism require extensive laboratory research, which must be integrated with advanced techniques such as high-precision liquid chromatography. However, these methods are financially burdensome for the agricultural sector.

When evaluating scientific literature on the correction and study of the lipid profile of milk, it is important to note that while some methods yield positive results in influencing the fatty acid composition, excessive inclusion of unsaturated fatty acids can result in negative consequences, including impaired digestibility of these fatty acids. Furthermore, disturbances in stable metabolism may adversely affect the rumen microflora, potentially leading to excessive carbonation of its contents. It should also be noted that in most scientific studies, limited attention is given to the systems involved in correcting lipid metabolism. Neglecting this aspect can significantly impact the reliability of baseline data when evaluating the exchange of energetically valuable substances, which may lead to considerable variability in results, complicating the statistical analysis of laboratory findings. The studies conducted by M. Hur *et al.* (2023),

W. Ren *et al.* (2023) and E. Li *et al.* (2024) provide a strong example of how the autonomic nervous system influences lipid metabolism, particularly the role of its components in lipogenesis and lipolysis. By analysing the results of milk fatty acid profiles using gas chromatography, these authors demonstrated a clear difference in the content of unsaturated fatty acids among the experimental groups. Specifically, depending on the influence exerted by the divisions of the autonomic nervous system – namely, the sympathetic and parasympathetic nervous systems – the intensity of metabolic processes in cows' bodies vary. This variation subsequently affects the lipid content of milk, which is synthesised in the mammary gland under the regulation of the body's homeostatic control systems.

Based on the obtained results, the authors emphasise the importance of analysing the activity of the autonomic nervous system to better predict lipid metabolism in cows' bodies and optimise feeding rations to address differences in metabolic processes.

Conclusions

The influence of the divisions of the autonomic nervous system, namely the parasympathetic and sympathetic nervous systems, on the parameters of unsaturated fatty acids, has been established, reflecting differences in the metabolic processes of lipid exchange in cows with varying sympatho-vagal balance. According to the initial data, differences were observed among the experimental groups of animals in the content of palmitoleic acid, myristoleic acid, linoleic acid, oleic acid, and α-linolenic acid.

It was determined that in cows with a predominance of vagotonia, the content of myristoleic acid was higher by 6.9% ($P < 0.05$) compared to animals with a balanced sympathovagal balance. Palmitoleic acid levels were higher in cows with a predominance of sympathotonia by 5.8% ($P < 0.05$) and in cows with a predominance of parasympathetic nervous system influence by 11.6% ($P < 0.01$) compared to the experimental group with normotonia. Oleic acid levels were higher in cows with a predominance of sympathotonia by 1% ($P < 0.05$) and in cows with a predominance of vagotonia by 4.2% ($P < 0.01$) compared to the experimental group with a balanced sympatho-vagal balance. Linoleic acid levels were higher in cows with a predominance of sympathotonia by 31.7% ($P < 0.001$) and in cows with a predominance of vagotonia by 6.1% ($P < 0.001$) compared to the experimental group with a balanced sympatho-vagal balance. Conversely, α-linolenic acid levels were lower in cows with a predominance of sympathotonia by 34.6% ($P < 0.01$) and in cows with a predominance of vagotonia by 38.5% ($P < 0.01$) compared to the experimental group with a balanced sympatho-vagal balance.

The future prospects for subsequent studies involve the use of biologically active additives, including nanopreparations, to improve lipid metabolism and cow productivity, while considering individual characteristics related to the tone of the autonomic nervous system.

Acknowledgements

None.

Conflict of Interest

None.

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Зміни показників ненасичених жирних кислот у молоці за вегетативної регуляції в корів молочного напрямку

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Анотація. Вміст жирних кислот у молоці є гарним показником якості продукції. Зміна даного показника залежить від багатьох факторів, що варто враховувати при застосуванні методів корекції жирнокислотного складу молока. Мета дослідження полягала у визначенні впливу на показники жирнокислотного складу молока автономної нервової системи в організмі корів молочного спрямування. Дослідження виконували на коровах породи українська чорно-ряба молочна. Формування дослідних груп виконувалося за допомогою електрокардіографії і встановлення тонусу автономної нервової системи. Жирнокислотний аналіз виконувався за допомогою газової хроматографії, екстракцію ліпідів виконували за методикою Фолча. Встановлено, що відсоткове співвідношення мірістоолеїнової кислоти у дослідної групи ваготоніків було більше в порівнянні з коровами, що мають нормотонію, на 6,9 % ($P < 0,05$). Вмісту пальмітолеїнової кислоти за результатами хроматографічного дослідження в молоці корів було більше у тварин з ваготонією на 11,6 % ($P < 0,01$) та у симпатотоніків на 5,8 % ($P < 0,05$) відносно корів з нормотонією. Вмісту олеїнової кислоти за результатами хроматографічного дослідження у молоці корів було більше у тварин із ваготонією на 4,2 % ($P < 0,01$) та у симпатотоніків на 1 % ($P < 0,05$) відносно корів із нормотонією. Вмісту лінолевої кислоти за результатами хроматографічного дослідження у молоці корів було більше у тварин із ваготонією на 6,1 % (Р < 0,001) та у симпатотоніків на 31,7 % (Р < 0,001) відносно корів із нормотонією. Вмісту α-ліноленової кислоти за результатами хроматографічного дослідження у молоці корів було менше у тварин із ваготонією на 38,5 % (Р < 0,01) та у симпатотоніків на 34,6 % (Р < 0,01) відносно корів із нормотонією. Згідно з отриманими результатами варто відмітити, що дослідна група нормотоніки мала найменші показники вмісту ненасичених жирних кислот у молоці

Ключові слова: жуйні; ліпіди; хроматографія; коров'яче молоко; виробництво молока