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## Fatty acids content in milk of cows under the influence of $\beta$ -carotene

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**Abstract.** For the enrichment of milk with vitamin A and  $\beta$ -carotene, vitaton is used, which contains up to 10% of trans- $\beta$ -carotene, which can be converted into vitamin A, and demonstrate antioxidant, immunostimulating and anticarcinogenic effects in the body. Previous studies have demonstrated that in sanitary terms, the biomass of the fungus *Bl. trispora* is safe for animals and can be used in animal husbandry to prevent diseases of the mammary gland, and digestive organs, increase reproductive function and obtain healthy viable offspring. The research was conducted on cows of the Ukrainian black-and-white dairy breed in the conditions of LLC "Kuibysheve", Poltava region. The purpose of the research was to determine the content of fatty acids in milk fat of lactating cows, as with the introduction of vitatons, lipids, higher saturated and unsaturated fatty acids, vitamins E and B, which to some extent can affect the processes of synthesis of milk components in the mammary gland. Determination of lipid content and their fractions in milk fat was performed on a gas chromatograph-mass spectrometer Agilent Technologies. Established that the introduction of vitaton in the diet for cows increases the fat content in milk by an average of 0.26% and enhances the synthesis of phospholipids in the mammary gland by 1.8 times. The ratio of unsaturated to saturated free fatty acids in the milk fat of cows of the experimental group did not vary from the control, which indicates a positive effect of  $\beta$ -carotene on the intensity of milk fat biosynthesis in the secretory epithelium of the mammary gland of cows. Vitaton stimulated the establishment and inclusion of two unsaturated fatty acids, namely nonadecanoic and  $\alpha$ -linolenic acids in the composition of milk fat against the background of the disappearance of the arachidonic acid peak on the chromatogram. It is established that the samples of milk fat from cows of the control group contained arachidonic acid, which was absent in the milk of cows of the experimental group, which is probably due to the inclusion of these higher fatty acids and their isomers, which are part of vitaton, in the composition

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of milk fat, and the effect of  $\beta$ -carotene on the synthesis of milk lipids. The results of the research are essential for the production of biologically complete milk and its products, which will have antioxidant properties and will be enriched with vitamin A and  $\beta$ -carotene

**Keywords:** lactating cows, milk, butter, milk lipids, vitamin, fatty acids

## Introduction

The production of high-quality and biologically complete livestock products is impossible without using several biologically active substances in animals, namely: macro- and microelements, immunostimulants, hepatoprotectors, antioxidants, dyes, flavouring, aromatic additives, vitamins and vitamin-like substances, including carotenoids. Their widespread use in the practice of livestock production is primarily associated with the prevention of diseases, stimulation of growth, development and productivity of animals, and improvement of the quality and biological value of livestock products (Ul Haq *et al.*, 2014; Lopes *et al.*, 2016; Wang & Bu, 2015; Hassan Rafiee *et al.*, 2016; Sukhikh *et al.*, 2019).

The transition of livestock production to industrial technologies requires a complete revision of the concept of providing animals with biologically active substances, including  $\beta$ -carotene, which is associated with the dry type of feeding of many species of farm animals, and hence the emergence of some problems in the preparation, storage and introduction of juicy fodders as a source of carotenoids into complete fodder (Shevchenko *et al.*, 2018; Abd El-Salam & El-Shibiny, 2020; Đorđević, Nenad *et al.*)

Currently, more than 600 carotenoids are known, and their structure, chemical properties and physical characteristics have been explored, which allows them to be used as antioxidants, stimulants of animal growth and development, photo- and radioprotectors, immunostimulants, precursors of vitamin A, dyes for

livestock products, etc. Scientists have explored the species composition of carotenoids in many plants, fungi, bacteria and algae, and explored their effect on the clinical condition, productivity, metabolism, reproductive capacity and quality of animal products (Shevchenko *et al.*, 2018; Lutfiye Yilmaz-Ersan *et al.*, 2018).

At present, the problem of providing the demand of animals with carotenoids remains unresolved, since there is no single concept for determining the efficiency of using both a mixture of carotenoids and their representatives, which have different effects on the body of animals, including provitamin.

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According to the latest data, it is known that the content of  $\beta$ -carotene in blood plasma and colostrum of cows does not always indicate a sufficient supply of their body vitamin A, while the concentration of vitamin A in colostrum is one of the most objective indicators in the diagnosis of A-hypovitaminosis of cows (Sakhniuk, 1997).

The content of carotenoids and vitamin A in cows' milk depends on the season of the year.

Thus, in the winter-stall period of keeping cows in milk, the lowest concentration of  $\beta$ -carotene and vitamin A is observed. During the transfer of animals to pastures, the level of  $\beta$ -carotene first increases, and later – the content of vitamin A in milk. In addition, the breed of cows has a significant impact on the accumulation of carotenoids in milk. Thus, the milk of cows of Shvitz, Simmental, Chervonogorbatov and Red Steppe breeds contains an average of 180 – 190  $\mu\text{g}/\text{kg}$  of carotene, in the milk of cows of the Brown Latvian breed – up to 240  $\mu\text{g}/\text{kg}$  of carotene, while the milk of cows of other breeds is much poorer in this biologically active compound (Carrara *et al.*, 2021).

The level of vitamin A and  $\beta$ -carotene in colostrum and milk of cows is largely determined by the composition of the diet and lactation period. Thus, the colostrum of the first milk yield contains 134.0  $\mu\text{g}/\text{l}$  of vitamin A and 396.0  $\mu\text{g}/\text{l}$  of  $\beta$ -carotene, the milk of the sixth milk yield – 80.0 and 60.0  $\mu\text{g}/\text{l}$ , and the tenth milk yield – 27.0 and 25  $\mu\text{g}/\text{l}$ , respectively. The transition of carotenoids into milk provides the intensity of its colour and largely depends on the breed characteristics of cows. A study of the colour of cow milk and its  $\beta$ -carotene content demonstrated that milk obtained from purebred Friesian cows contained less  $\beta$ -carotene than that from non-purebred cows (Strickland *et al.*, 2021).

The accumulation of carotenoids in cattle fat is influenced by age and feeding level. Thus, the accumulation of carotenoids in fat is less intense in free-feeding bulls at the age of one and two years than in restricted feeding (Boom & Sheath, 1997; Retrini *et al.*, 2022).

One of the ways to increase the level of carotenoids and retinol in milk is the development and implementation of biologically active fodder supplements for cows. Several studies by leading scientists of the CIS countries, the USA

and Japan are devoted to this issue. Thus, feeding dry cows with  $\beta$ -carotene of microbial origin at a dose of 15 g per head per day increased the level of vitamin A in the milk of the first milk yield by 33.8%, and carotene – by 26.8% compared to animals that did not receive this supplement. The same dependence persisted on the fifth to the seventh day of lactation (Vargas-Bello-Pérez *et al.*, 2020).

Partial replacement of silage  $\beta$ -carotene with  $\beta$ -carotene of microbial origin improves the saturation of colostrum and milk of Holstein cows both with carotene and vitamin A and with protein (Ulytko *et al.*, 1997). In addition, several studies have confirmed the superiority of carotene of microbial origin over the carotene of corn silage, alfalfa and coniferous flour. Therewith, it was established that the level of vitamin A in the colostrum of cows fed with microbial  $\beta$ -carotene was the highest, which exceeded the value in animals fed with silage by 1.71 and 1.57 times, respectively. In the milk of cows of this group, a similar pattern of  $\beta$ -carotene accumulation was observed (Ulytko & Dushkyn, 2002).

Replacement of 32–43% of silage carotene in cow diets with carotene of microbial origin allowed for increasing milk productivity of cows by 9.7–14.0% and contributed to an increase in milk fat content, particularly during the winter-stall period (Alekseeva *et al.*, 2001; Yemets & Mamenko, 2020). Using lipocarotene (an oil extract of the biomass of the fungus *Bl. trispora*) in the feeding of cows at a dose of 20 ml per head per day contributed to an increase in productivity by 0.5 kg of milk per day, fat content in milk – by 0.2% (Kartamysheva & Khmelkov, 2006; Yakubchak *et al.*, 2018).

The transformation product of  $\beta$ -carotene – vitamin A significantly affects the quality of cows' milk. Thus, the inclusion of vitamin A

in the composition of fodder for cows in a dose increased by 10 and 25% compared to the demand, contributing to an increase in average daily milk yield by 6.3-10.3%. The milk of cows that consumed fodder with a high content of vitamin A contained more fat (by 0.29-0.50%) and protein (by 0.12-0.18%). Therewith, it was more thermostable and withstood exposure to 80% alcohol concentration against 72% in the control (Belykova *et al.*, 2005).

There is an opposite standpoint on the accumulation of carotenoids in animal products. Thus, using pasture cattle in Zealand causes the problem of increased carotenoid content in carcass fat and milk fat, which, from the standpoint of experts, worsens the marketability of meat and dairy products. To solve this problem, the Zealand scientists developed a lifetime test for determining the degree of yellowness of fat in cattle carcasses, which is based on the determination of the ratio of cholesteryl and plasma carotenoids (Knight *et al.*, 2001). In addition, the yellowness of fat correlates with the content of saturated and monounsaturated fatty acids. The authors conclude that the advantages of yellow fat meat over white fat meat are insignificant (Knight & Death, 1997).

On the other hand, the increase in the content of carotenoids and vitamin A in milk and its processed products is of interest to specialists in terms of creating mass and specific food products enriched with vitamins, particularly antioxidants. According to the All-Russian Health Organisation, milk and dairy products in the human diet constitute at least 50%, and they occupy the same place in the diets of the population of Ukraine and other countries of the world. XXV and XXVI International Dairy Congresses (1998, 2002) were dedicated to the establishment and development of functional dairy products (Vasheka & Rashevskaya, 2005;

Galstian & Avetysian, 2005; Zielinska *et al.*, 2019).

Thus, notably, the problem of their establishment is solved mainly by using the introduction of oil extracts and cryopowders of biologically active substances into finished products (Hryhoreva, 2003).

As for  $\beta$ -carotene, it is added to milk in the form of 1% concentrate based on 30% paste based on CPMC. Thus, its concentration in the finished product is 50 mg/kg, which does not affect the viability of lactic acid bacteria such as bifidobacteria, bacillus and *Str. termophilus* provides further processing of milk (Narushyn, 2004; Katserykova *et al.*, 2000), improves organoleptic properties and prolongs the shelf life of this product (Polianskyi *et al.*, 2001).

Thus,  $\beta$ -carotene is introduced into the composition of dairy products such as butter, which contains 0.03% of this biologically active substance in the finished product. However, there is another standpoint on the direct introduction of  $\beta$ -carotene preparations of microbial origin into food products. There is evidence of the intake of foreign metabolic products of fungi producing carotenoids into the human body, which can cause various disorders in body tissues and cause side effects (Mahintha, 2022; Ulfman, 2022).

Thus, using  $\beta$ -carotene in cows feeding solves both the issues of prevention of diseases of the mammary gland and digestive organs, reproduction and obtaining healthy viable offspring and production of biologically complete milk and its products. However, the problem of obtaining milk with a high content of  $\beta$ -carotene and vitamin A remains unresolved due to the lack of scientifically sound recommendations on using new sources of natural  $\beta$ -carotene (especially microbial synthesis) in cow feeding, in-depth studies on quality, and biological integrity and sanitary safety of the products.

*The purpose of the research.* The purpose of the research was to determine the content of fatty acids in milk fat of cows with the addition of vitaton with  $\beta$ -carotene content of 5% to their diet.

## Materials and Methods

In the experiment, the efficiency of using  $\beta$ -carotene of the fungus *Bl. trispora* in cows was determined to improve the quality of milk at different types of feeding. For this purpose, two groups of cows of the Ukrainian black-and-white dairy breed were established: control and experimental in LLC "Kuibysheve", Poltava region. The cows of the experimental group (189 cows) were fed vitaton with  $\beta$ -carotene content of 5% in addition to the fodder of the main diet. The dose of vitaton for lactating cows was 2 kg/t of fodder. The experiment lasted 120 days. Animals of the control group (216 cows) were fed fodder of the main diet. Average daily milk samples were collected monthly to determine the quality and production of butter in which the content of carotenoids, vitamin A and fatty acids was determined.

Determination of lipid content and their fractions in milk fat was performed by chromatographic separation in thin layers of silica gel (Silufol, Czech Republic) using a system of solvents hexane:diethyl ether:acetic acid in a ratio of 76:23:1. The content of individual lipid fractions was determined using a densitometer after staining chromatograms with 5-10% phosphoric-molybdenum acid solution in ethanol. Chromatograms were developed for 4-5 min at 90-110°C (Veselskyi *et al.*, 2001).

The fatty acid content of butter was determined after saponification and extraction with hexane. The obtained methyl esters were analysed on a gas chromatograph-mass spectrometer Agilent Technologies 6890N/5973 N, chromatographic column DB-5MS; L=30 m; Id=0.25 mm, catalogue No. 122-5532 Agilent Technologies, F: lm=0.25 mm, carrier gas – helium (DSTU ISO 5508:1990, 2003). The research results were processed statistically (Kokunyn, 1975).

## Results and Discussion

Dairy productivity and milk quality of cows are determined primarily by the clinical condition of animals, the intensity of metabolic processes in the tissues of the body and the mammary gland, which are closely related to the level of supply of nutrients and biologically active substances, including vitamin A and its precursor  $\beta$ -carotene. The introduction of vitaton as a source of  $\beta$ -carotene into the composition of lactating cows' fodder provides for the intake of lipids, higher saturated and unsaturated fatty acids, and vitamins of groups E and B, which to some extent can affect the processes of synthesis of milk components in the mammary gland of cows.

Assimilation and transport of  $\beta$ -carotene and retinol in the digestive apparatus of animals are closely related to lipid metabolism, namely with the absorption of higher fatty acids into the blood and lymph and their participation in the synthesis of milk fat, as evidenced by an increase in milk fat content by an average of 0.26% compared to the control (Table 1).

**Table 1.** Physicochemical properties of cow milk, %,  $M \pm m$ ,  $n=6$

Indicator	Group	
	Control	Experimental
Fat	4.21 $\pm$ 0.04	4.47 $\pm$ 0.06*
SMMG	8.52 $\pm$ 0.07	8.58 $\pm$ 0.10
Density, g/cm <sup>3</sup>	1.027 $\pm$ 0.0002	1.027 $\pm$ 0.0005

Table 1. Continued

Indicator	Group	
	Control	Experimental
Protein	3.07±0.03	3.10±0.03

The increase in fat content in the milk of cows of the experimental group with vitaton supplementation is consistent with an increase in the synthesis of phospholipids in the mammary gland by 1.8 times compared to the control (Table 2). The data obtained are consistent with the results of previous studies, namely, the increased content of phospholipids in the

colostrum of the first milk of cows when feeding them vitaton during the dry period.

The content of free and esterified cholesteryl in the milk of cows fed with vitaton was at the level of animals of the control group, which indicates the absence of adverse effects of  $\beta$ -carotene on the processes of transport and absorption of cholesteryl in the tissues of cows.

**Table 2.** Composition and lipid content of cow milk, mg/100 ml,  $M\pm m$ ,  $n=4-5$ 

Indicator	Group	
	Control	Experimental
Phospholipids	28.07±1.50	50.15±6.57*
Free cholesteryl	24.78±3.33	31.76±4.55
Esterified cholesteryl	22.68±1.77	23.48±1.64
Higher fatty acids (short-chain)	18.68±2.24	25.52±4.44
Higher fatty acids (long-chain)	25.36±1.74	30.52±3.95
Diglycerides, g/l	11.05±0.66	12.86±0.58
Triglycerides, g/l	24.13±0.67	27.22±2.23

The content of di- and triglycerides in the milk of cows using vitaton in the first 30 days of lactation did not differ significantly from the same indicators of milk obtained from cows of the control group.

Feeding vitaton to lactating cows did not affect the total content of higher fatty acids, both short- and long-chain, in milk compared to the control, which is consistent with the data of free fatty acids analysis by gas chromatography-mass spectrometry (Table 3).

Therewith, the total content of saturated acids: caprylic, caproic, lauric, myristic,

pentadecanoic, palmitic, margarine, stearic, and unsaturated acids: oleic, palmito-oleic and linoleic in milk fat obtained from the milk of cows of the experimental group with vitaton feeding was at the level of animals of the control group.

Notably, the ratio of the total content of saturated to unsaturated fatty acids in the milk of cows under the action of vitaton was at the level of animals of the control group, which indicates the absence of influence of the components of the biologically active additive on the processes of milk fat synthesis.

**Table 3.** Total fatty acid content in butter (fat content 78%), mg/kg,  $M\pm m$ ,  $n=3$ 

Fatty acid	Group	
	Control	Experimental
Caprylic	1845.28±224.75	1504.97±149.55

Table 3. Continued

Fatty acid	Group	
	Control	Experimental
Capric	12451.41±713.90	7112.15±758.82
Lauric	8213.44±384.68	11602.94±871.35
Tridecylic	205.51±39.13	782.62±39.62
Myristic	78457.44±5593.35	70969.54±9592.81
Pentadecylic	5830.38±611.55	4032.86±322.87
Palmitic	311282.37±32074.00	270485.75±5959.82
Margaric	4329.72±747.52	3180.64±349.63
Stearic	104944.42±17887.20	81676.94±2940.12
Nonadecylic	-	565.57±76.21
Arachidic	960.80±135.54	784.35±43.82
Oleic	238021.59±36561.72	207070.65±5801.40
Palmitoleic	7527.23±586.73	6345.99±218.76
Linoleic	21429.86±2321.98	14166.37±754.52
$\alpha$ -Linolenic	-	803.61±112.53
Arachidonic	1032.35±125.73	-
Total acid content	795775.06±10280.48	680172.18±16993.12
including the content of saturated acids	528452.26±50105.91	452321.31±10233.01
unsaturated acids	267322.80±5300.48	227850.87±6760.26
Ratio of unsaturated to saturated acids	1:2	1:2
Share of saturated acids in their total content, %	66.4	66.5

The level of free fatty acids in the milk of cows fed with vitaton was at the level of similar indicators of the control group,

which is consistent with the total level and content of conjugated fatty acids in milk fat (Tables 4, 5).

**Table 4.** Content of free fatty acids in butter (fat content 78%), mg/kg,  $M\pm m$ ,  $n=3$

Fatty acid	Group	
	Control	Experimental
Caprylic	416.76±24.80	402.40±27.41
Capric	1110.66±58.84	1281.93±42.37
Lauric	1704.59±83.29	1682.09±117.56
Myristic	7813.09±380.00	8932.66±547.31
Pentadecylic	941.89±143.86	586.14±36.15
Palmitic	29593.35±2628.12	22020.50±1589.69
Margaric	603.75±127.76	473.37±17.47
Stearic	8682.99±462.70	8663.43±513.82
Oleic	22518.57±2253.62	16358.52±1185.70

Table 4. Continued

Fatty acid	Group	
	Control	Experimental
Palmitoleic	1446.82±282.09	1001.71±145.82
Linoleic	3764.94±352.26	2032.11±244.65
Total acid content	76209.21±6158.21	56228.79±3999.42
including the content of saturated acids	50216.12±4713,99	37847.70±2689.85
unsaturated acids	25993.06±3452.37	18381.09±1311.09
Ratio of unsaturated to saturated acids	1:1.9	1:2
Share of saturated acids in their total content, %	65.9	67.3

As it can be seen from the data obtained, the main proportion of free fatty acids in milk fat of cows with vitaton feeding is oleic and palmitic, which respectively 29 and 39% of the total free fatty acids, which were at the level of similar indicators in the control.

The ratio of unsaturated to saturated free fatty acids in the milk fat of cows of the experimental group did not vary from the control, which indicates a positive effect of  $\beta$ -carotene on the intensity of milk fat biosynthesis in the secretory epithelium of the mammary gland of cows.

**Table 5.** Content of conjugated fatty acids in butter (fat content 78%), mg/kg,  $M\pm m$ ,  $n=3$ 

Fatty acid	Group	
	Control	Experimental
Caprylic	1567.45±428.06	1236.70±167.61
Capric	11340.88±765.72	5830.21±105.42
Lauric	6508.86±322.18	9920.85±168.11
Tridecylic	205.51±39.13	782.62±39.62
Myristic	70644.35±9443.61	65014.43±8204.58
Pentadecylic	5202.45±128.93	3642.09±409.50
Palmitic	281685.69±28216.69	248465.26±5680.12
Margaric	3927.22±102.88	2707.30±166.71
Stearic	96261.44±1853.98	75901.31±2853.90
Nonadecylic	-	565.57±56.73
Arachidic	960.80±35.54	784.35±43.82
Oleic	215503,04±3538,89	190712.09±5509.38
Palmitoleic	6562.69±251.15	5678.18±208.70
Linoleic	18919,90±1193.85	12811.62±724.11
$\alpha$ -Linolenic	-	803.61±76.53
Arachidonic	1032.35±109.99	-
Total acid content	719565.91±10325.12	623943.40±16264.88
including the content of saturated acids	478236.13±55346.21	414473.63±9823.51
unsaturated acids	241329.74±4988.02	209469.80±6449.43

Therewith, notably, during the feeding of vitaton in the milk of cows of the experimental group, two unsaturated acids appeared, namely nonadecanoic and  $\alpha$ -linolenic acids, which were identified as conjugated compounds, probably di- or triglycerides, while in the samples of milk fat from cows of the control group contained arachidonic acid, which was absent in the milk of cows of the experimental group. It is probably connected with the inclusion of these higher fatty acids and their isomers, which are part of vitaton, in the composition of milk fat, and the influence of  $\beta$ -carotene on the synthesis of milk lipids.

### Conclusions

Thus, it can be concluded that the biomass of the fungus *Bl.trispora* strain TKST (vitaton) is an effective source of  $\beta$ -carotene for animals, as it contains a high concentration of active substances (10-12% in terms of dry matter) and a complex of biologically active substances that promote the absorption and transformation of carotenoids in the body of animals.

It was established that feeding lactating cows with vitaton as a source of natural  $\beta$ -carotene does not significantly affect the content and ratio of free fatty acids in milk fat, but promotes the inclusion of nonadecanoic and  $\alpha$ -linolenic fatty acids instead of arachidonic fatty acids in the conjugated form in milk lipids.

Further research in this area will allow obtaining of dairy products with antioxidant properties, which will be enriched with vitamin A and  $\beta$ -carotene. And considering the properties of vitaton and the introduction of trans- $\beta$ -carotene of *Bl. trispora* fungus into animal fodder can significantly affect the processes of gene transcription and regulation of reproductive capacity, homeostasis of the antioxidant defence system, tissue regeneration and immune protection, and improve the biological integrity of products, which will preserve the health of animals, extend their productive life, obtain healthy viable offspring and increase the efficiency of livestock production.

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## **Вміст жирних кислот в молоці корів за дії $\beta$ -каротину**

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**Анотація.** Для збагачення молока вітаміном А та  $\beta$ -каротином, використовують вітатон, який містить до 10 % транс- $\beta$ -каротину, здатного перетворюватись у вітамін А, а також проявляти антиоксидантну, імуностимулюючу і антиканцерогенну дію в організмі. Дослідженнями, які були проведені нами раніше, встановлено, що в санітарному відношенні біомаса гриба *Bl. trispora* є безпечною для тварин і може використовуватися у тваринництві для профілактики захворювань молочної залози, органів травлення, підвищення відтворної функції та одержання здорового життєздатного потомства. Дослідження було проведено на коровах української чорно-рябої молочної породи в умовах СТОВ «Куйбишеве» Полтавської області. Метою досліджень було встановити вміст жирних кислот у молочному жирі лактуючих корів, тому що, при введенні вітатону, до організму тварин надходять також ліпіди, вищі насичені та ненасичені жирні кислоти, вітаміни групи Е та В, що певною мірою може впливати на процеси синтезу компонентів молока в молочній залозі. Визначення вмісту ліпідів та їх фракцій у молочному жирі проводили на газовому хромато-мас-спекрометрі Agilent Technologies. Встановлено, що введення вітатону до складу раціону для корів сприяє збільшенню вмісту жиру в молоці в середньому на 0,26 % та посиленню синтезу фосфоліпідів у молочній залозі в 1,8 раза. Співвідношення ненасичених до насичених вільних жирних кислот у молочному жирі корів дослідної групи не відрізнялося контролю, що свідчить про позитивний вплив  $\beta$ -каротину на інтенсивність біосинтезу молочного жиру у секреторному епітелії молочної залози корів. Вітатон стимулював утворення та включення до складу молочного жиру двох ненасичених жирних кислот, а саме наонадеканової та  $\alpha$ -ліноленової на фоні зникнення на хроматограмі піку арахідонової кислоти. Встановлено, що у зразках молочного жиру в корів контрольної групи містилася арахідонова кислота, яка була відсутня в молоці корів дослідної групи, що, ймовірно, пов'язано з включенням цих вищих жирних кислот та їх ізомерів, що входять до складу вітатону, до складу молочного жиру, а також впливом  $\beta$ -каротину на синтез ліпідів молока. Результати дослідження важливі для виробництва біологічно повноцінного молока і продуктів його переробки, що матимуть антиоксидантні властивості і будуть збагачені вітаміном А та  $\beta$ -каротином

**Ключові слова:** лактуючі корови, молоко, масло вершкове, ліпіди молока, вітатон, жирні кислоти