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Exchange of polynonsaturated fatty acids of families omega-3 and omega-6 in an organism of repair heifers in the age of 6 – 12 months

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The purpose. To determine regularities of exchange of essential biologically active polynonsaturated fatty acids of families omega-3 and omega-6 in an organism of repair heifers in the age of 6 – 12 months at application in rations of feeding of rape oil. **Methods.** Experiment was lead in 2 groups of repair heifers of 6 – 12-months age of Ukrainian black-motley dairy breed in amount of 20 animals with application of methodical approaches accepted in international practice according to demands of ISO 17025, and also according to conventional procedures of groups-analogues on clinically able-bodied animals, considering age and mass of a body. For assessment of the selected material (feedstuffs and blood plasma of animals) they used modern biochemical methods of probes (gas-liquid chromatography and photocolorimetry). **Results.** The amount of fatty acids of families omega-3 and omega-6 in ration and blood plasma of experimental repair heifers is determined. It is fixed that as a result of addition of rape oil and synthetic joint Doksan into ration of heifers of the tested group, in comparison to control one, in their blood plasma in 8-9-months age due to more intensive conversion of biologically active polynonsaturated fatty acids the density of fatty acids of families omega-3 (linolenic) and omega-6 (linolic) is authentically augmented. It is established also that owing to heightening biological and energy value of ration of heifers of test group, in comparison to control one, energy of their body height is increased. **Conclusions.** Owing to addition of rape oil biological and energy value of ration of repair heifers increase. In their blood plasma density of biologically active polynonsaturated fatty acids of families omega-3 and omega-6 is augmented. Addition of rape oil and synthetic joint Doksan into ration raises growing capacity and augments mass of body of repair heifers.

Key words: *repair heifers, essential biologically active polynonsaturated fatty acids of families omega-3 and omega-6, rape oil.*

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The indispensable polyunsaturated fatty acids of the omega-3 and omega-6 families provide functional activity of plasma and cell membranes and are precursors of a range of biologically active substances (prostaglandins, thromboxanes, leukotrienes) that are responsible for the intensity of metabolic processes in the body and the productive features of animals. Therefore, polyunsaturated fatty acids of omega-3 and omega-6 families must necessarily be present in sufficient quantities in feed rations of animals. However, by this time, their amount in the diet, which would ensure a high intensity of metabolic processes in the body and, accordingly, higher growth rates in repair heifers aged 6-12 months has not been established,

According to our preliminary data, the content of biologically active polyunsaturated fatty acids of omega-3 and omega-6 families in the feed is insufficient, therefore they should be added to the animals' diet. Their concentration is high in vegetable fats, in particular, rapeseed oil. Therefore, the determination of the influence of fatty acids, that are part of the rapeseed oil, on the intensity of conversion and retention in the body and the productive signs of heifers deserves attention.

Analysis of recent researches and publications. Currently, the biochemical peculiarities of the exchange of certain nutrients contained in rapeseed oil, namely, biologically active polyunsaturated fatty acids of omega-3 and omega-6 families, in the body of repair heifers aged 6-12 months, have been studied fragmentarily [1-3]. Separate studies have shown, that the feeding of fat supplementation to the

young cattle may affect the intensity of metabolism in their body [3]. To balance the diets of repair heifers, fats of animal origin [4] are often used, as protected by various methods from biohydrogenation and dehydration by rumen microorganisms [5] as well as unprotected [5, 6], which, however, can negatively affect the processes of digestion in the rumen, in other parts of the complex stomach of ruminants, as well as in subsequent compartments of their gastrointestinal tract [7]. There is also no reliable information on the influence of biologically active polyunsaturated fatty acids of the omega-3 and omega-6 families of rapeseed oil on the growth and development of heifers aged 6-12 months [8].

However, the study of the fatty acids content of omega-3 and omega-6 families in rapeseed oil and the patterns of their metabolism in the body of cattle, their effect on the intensity of growth of heifers 6-12 months of age is on agenda and has a scientific and practical value [9].

The scientific novelty of the work is that: for the first time an optimal amount of biologically active polyunsaturated fatty acids of omega-3 and omega-6 families in the diet has been established, which provides a high level of exchange of certain nutrients in the body and growth of repair heifers aged 6-12 months.

The purpose of the research is to establish the peculiarities of the exchange of certain feed nutrients, namely, the essential biologically active polyunsaturated fatty acids of the omega-3 and omega-6 families in the body and their effect on the growth of the body weight of repair heifers aged 6-12 months by using in rations of feeding rapeseed oil.

Materials and methods of research. The scientific research was carried out at the State Enterprise "Radekhivske" of the Radekhiv district of Lviv region on 2 groups of repair heifers 6-12 months old Ukrainian black-and-white milk breed in a quantity of 20 heads using methodological approaches that are used in international practice in accordance with requirements of ISO 17025, as well as according to generally accepted methods of analogue groups on clinically healthy animals.

Animal groups were formed taking into account age and weight of the body. During the experiment, the chemical composition of feed was determined according to generally accepted methods [10]. Modern biochemical methods of investigation (gas-liquid chromatography and photocolorimetry) were used to evaluate the selected material (feed and blood plasma of animals) [11]. The scheme of experiment is presented in Table 1.

1. The scheme of experiment

Group	Number of animals	Nature of feeding
Control	10	Basic diet (BD)
Experiment	10	BD + rapeseed oil (0.5 ml / kg of body weight) + "Doxan" (2 mg / kg of body weight)

The weight of the repair heifers body was established by means of control weights every month on barn weights. Starting from 6- and to 12 months of age of repair heifers the control and experimental group was fed the feed of the main diet, the composition of which is given in Table 3 and 4. The rations were balanced by detailed norms [12]. During the experiment, materials were collected monthly for laboratory studies, namely: diet rations and blood taken from the jugular vein from 5 animals from each group after morning feeding. In the feeds and blood plasma the content of biologically active polyunsaturated fatty acids of the omega-3 and omega-6 families by the means of gas chromatography was determined [11].

For repair heifers of the experimental group aged 7-9 month, in addition to the mixed fodder, low-erucik rapeseed oil was fed in the amount of 0.5 ml / kg of body weight (producer: Mayola, Stavchany village, Pustomyty district, Lviv region). In order to reduce the intensity of biohydrogenation of unsaturated and polyunsaturated fatty acids contained in rapeseed oil, the synthetic substance "Doxan" was added to the mixed fodder of repair heifers of the experimental group in the amount of 2 mg / kg of body mass [13].

The active substances of "Doxan" are sodium dodecyl sulfate and synthetic cation copolymer of vinylpyrrolidone which in an aqueous medium are forming a polyelectrolyte complex. Due to the specificity of its structure, this polycomplex, when introduced into the body of animals with food or drinking water, shows its own biological activity, in particular, surface activity.

Biometric processing of the received digital material was carried out by the method of variational statistics, taking into account the Student's criterion [14, 15]. Standard mathematical statistics programs, in particular EXCEL, were used to assess the reliability of the obtained results – average arithmetic values (M), errors of arithmetic mean (± m) and the probability of differences between the arithmetic mean values (P). Changes were considered probable by $P < 0.05$.

Research results. The fatty acid composition of rapeseed oil, which was added to the diet of the experimental group in the amount of 0.5 ml / kg of body weight per day, is given in Table 2.

2. Fatty acid composition of rapeseed oil, %

Fatty acids and their Code	Content in oil
Kaprinic, 10:0	1,0
Laurinic, 12:0	2,1
Myristinic, 14:0	3,2
Pentadecanic, 15:0	4,8
Palmitinic, 16:0	10,4
Palmitoleic, 16:1	1,2
Stearinic, 18:0	9,4
Oleinic, 18:1	36,8
Linolic, 18:2	18,4
Linolenic, 18:3	10,9
Arachinic, 20:0	0,2
Eikozaenic, 20:1	0,2
Erucik, 22:1	1,4

As we see, the rapeseed oil in a large amount contains the precursors of biologically active irreplaceable polyunsaturated fatty acids of omega-3 and omega-6 families, respectively linolenic and linoleic acids, which in the organism of the animal are predecessors of more long-chain and more unsaturated fatty acids, respectively eicosapentaenoic, docosaenic, docosapentaenoic, docosahexaenoic and eicosadienic, eicosatrienic, eicosatetraenic-arachidonic, docozadienic, docosatetraenic.

It has been established that the content of linolenic acid in the diet ranges from 111.8 g in the 6-month to 145.8 g in 9-month heifers, while the linoleic content is 121.7 g to 142.6 g, respectively. As a result of the rapeseed oil addition to the ration of the experimental group heifers, the amount of omega-3 fatty acids in it increases by 6.7-9.2%, and the omega-6 by 8.2-11.3% (Table 3).

3. Quantity of fatty acids of omega-3 and omega-6 families in the diet of repair heifers, g (M±m, n=5)

Age, month	Families of fatty acids			
	omega-3	omega-6	omega-3	omega-6
	control group		experimental group	
6	111,8±2,61	121,7±2,22	121,4±0,80**	133,8±3,52*
7	116,3±3,14	127,6±4,37	125,3±3,44*	139,9±4,61*
8	128,8±2,44	131,3±3,61	137,6±2,5*	141,6±3,92*
9	134,9±3,29	135,3±3,93	145,8±3,48*	142,6±3,95*

10	123,7±1,89	115,4±1,21	139,6±4,77*	127,4±3,71*
11	116,2±1,09	113,9±1,08	129,9±3,17**	133,7±1,95***
12	106,6±1,25	113,8±2,53	122,9±1,50**	133,7±2,77***

Note: here and below * - p <0,05; ** - p <0.01; *** - p <0.001.

As a result of the rapeseed oil and synthetic compound "Doxan" introduction to the diet of heifers of the experimental group, compared to control, in their blood plasma at the age of 8-9 months due to the more intensive transformation of biologically active polyunsaturated fatty acids, the concentration of linolenic and linoleic acids is significantly increased. These substances in the 7-month age only tend to increase (Table 4).

4. Concentration of fatty acids of omega-3 and omega-6 families in blood plasma of test heifers, g·10^{-3}/l (M±m, n=5)

Age, month	Families of fatty acids			
	omega-3	omega-6	omega-3	omega-6
	control group		experimental group	
6	101,9±3,98	655,1±10,36	101,8±4,17	653,7±11,67
7	119,0±3,78	684,7±10,43	128,6±3,83	701,6±11,65
8	125,9±2,68	744,4±15,35	140,6±1,74**	805,7±4,12**
9	136,5±4,0	779,1±22,77	156,9±2,16**	866,9±4,84**
10	118,8±1,82	702,1±7,42	126,7±1,37**	726,6±1,91*
11	111,6±3,54	699,5±7,25	124,9±1,53**	722,3±1,56*
12	138,5±4,98	743,3±11,24	159,1±1,12**	857,2±2,62***

Increase of the biological and energetic value of the experimental group heifers' ration has led to an increase in the energy of their growth, which is already evident from 7 months of age (Table 5). At the age of 9 months, the heifers of the experimental group almost by 5% by weight dominated the animals of the control group, and in 12 months – by 6.7%.

5. Dynamics of body weight of test heifers, kg (M±m, n=10)

Age of heifers, months	Control group	Experimental group
6	170,1±1,62	169,7±1,58
7	188,4±1,92	195,1±1,77
8	207,2±1,59	216,8±1,34*
9	226,1±1,16	237,3±1,05*
10	247,2±4,57	259,6±4,18**
11	266,4±5,11	281,8±5,90**
12	285,1±5,77	304,0±5,91**

During the experiment, the average daily weight gain of the control group heifers was 648.1 ± 5.2 g, of the experimental one – 715.8 ± 4.3 g, the absolute weight increase was respectively 115.0 and 134.3 kg.

Thus, as a result of the introduction of rapeseed oil and synthetic compound "Doxan" into the heifers' diet in their blood plasma in the age of 6-12 months, due to more intensive transformation, the content of biologically active polyunsaturated fatty acids of the omega-3 (linolenic) and omega-6 (linoleic) families increases. Due to this, as well as due to increased biological and energetic value of the experimental group repair heifers feed ration (due to the addition of rapeseed oil) compared with the control group animals, increases the growth rate of heifers.

Conclusions

1. Introduction of rapeseed oil to the main feed of the repair heifers' aged 8-12 months leads to an increase in the biological value of the diet by 15.3 – 17.4 %, and the energetic value by 7.4 %.

2. Due to the introduction of rapeseed oil and synthetic compound "Doxan" to the diet, in blood plasma of repair heifers at the age of 8-12 months as a result of more intensive transformation of irreplaceable polyunsaturated fatty acids – linolenic and linoleic – the concentration of biologically active polyunsaturated fatty acids of the omega-3 family increases by 14.9 % and of omega-6 family – by 15.3 %.

3. Introduction of rapeseed oil and synthetic compound "Doxan" due to the increase of biological and energetic value of the feeds leads to an increase in the repair heifers' body weight at the age of 8-12 months and the average daily weight gain by 4.6 – 6.6 %.

Prospects for further research in this area – the study of metabolism, conversion, retention and transformation of essential fatty acids in the body of repair heifers in the age dynamic.

Bibliography

1. *Aliev A.* (2007). Dostizheniya fiziologii pischevareniya selskohozyaystvennyh zhivotnyh v XX veke. Selskohozyaystvennaya biologiya. [Achievements of digestive physiology of agricultural animmals in XX century. Agricultural biology]. Moskva: Rosselhozizdat, P. 12–13. [in Russian].

2. *Desyatov O., Pyhtina L., Chernyshkova E.* (2015). Morfo-biohimicheskiy status krovi vysokoproduktivnyh korov pri ispolzovanii kormovyh dobavok omega-3-aktiv i polisol-omega-3 ; metod. posobie. [Morfo-biochemical status of high-produktive cows' blood by use of feed additives omega-3-aktiv and polisol-omega-3 ; metod. manual]. Moskva: Selhozizdat, 116 p. [in Russian].

3. *Doig B.* Beef Cow Rations and Winter Feeding Guidelines. *Saskatchevan Agriculture.* 2008. V. 82. P. 73–78.

4. *Lough A., Smith A.* Influence of the products of phospholipolysis of phosphatidylcholine on micellar solubilization of fatty acids in the presence of bile salts. *Brit. J. of Nutr*. 2011. V. 35. P. 89–96.

5. *Hazipov N.* (2016). Podgotovka kormov k skarmlivaniyu : metod. rek. [Feeds processing before feeding : metod. manual] *Byul. Kazanskogo NII kormovyh dobavok.* [Bulletin of Kazan SRI of feed additives]. V. 74. P. 178–184. [in Russian].

6. *Givens D.* (2014). Nutritional characterisation of forages. *Grass Farmer*. V. 55. P. 10.

7. *Miron J., Ben-Ghedalia D., Morrison M.* (2010). Adhesion Mechanisms of Rumen Cellulolytic Bacteria. *J. Dairy Sci*. V. 84. P. 1294–1309.

8. *Demeyer D., Van Nevel C.* (2009). Influence of substrate and microbial interaction on rumen microbial growth. *Reprod. Nutr. Dev.* V. 26. P. 161–179.

9. *Kazachkova N., Mescheryakov A.* (2009). Perevarimost pitatelnyh veschestv ratsionov u remontnyh telok, poluchavshih kombikorma s saharosoderzhaschimi komponentami. [Digestability of useful substances of rations in repair heifers, which were fed concentrates with sacharose-containing components] *Byul. Vseros. NII myasnogo skotovodstva RASHN.* [Bulletin of Russian SRI of meat breeding RAAS]. V. 17. P. 178–194. [in Russian].

10. Laboratorni metody doslidzhen u biologiyi, tvarynnytstvi ta veterynarniy medytsyni : dovidnyk [Laboratory methods of research in biology, animal sciences and veterinar medicine : manual] / edited by V. V. Vlizlo. Lviv, 2012. 759 p. [in Ukrainian].

11. *Rivis Y., Shelevach A., Fedak V., Gopanenko O., Saranchuk I.* (2017). Kilkisni hromatografichni metody vyznachennya okremyh lipidiv i zhyrnyh kyslot u biologichnomu materiali : posibnyk. Vyd. 2-ge, utochn. ta dop. [Quantitative chromatografic methods of particular lipids and fatty acids determination in biological material : manual. 2-nd redaction, precised and with addition]. Lviv: Spolom, 160 p. [in Ukrainian].

12. *Bogdanov G., Kandyba V.* (Eds). (2012). Normy i ratsiony povnotsinnoyi godivli vysokoproduktyvnoyi velykoyi rogatoyi hudoby : dovidnyk-posibnyk [Norms and rations of adequate high-produktive cattle feeding: manual]. Zhytomyr: Ruta. 860 p. [in Ukrainian].

13. *Novakov I.* (2005). Kompleksy polielektrolitov s elektrostaticheski komplementarnymi poverhnostno-aktivnymi veschestvami [Polyelektrolit complekses with elektrostatic komplementar surface-aktive substances]. *Izvestiya Volgogradskogo gosudarstvennogo tehnicheskogo universiteta* [News of Volgograd state technical university]. V. 2, # 1. P. 1–16. [in Russian].

14. *Plohinskiy N.* (1970). Biometriya [Biometrics]. Moskva: Selhozizdat, 395 p. [in Russian].

15. *Lopach S., Chubenko A., Babich P.* (2011). Statisticheskie metody v mediko-biologicheskih issledovaniyah s ispolzovaniem Excel [Statistical metods in medic-biological researches using Excel]. Kiev: Agrarian science. 408 p. [in Russian].