Rapeseed components cleanse the milk and the body of cows from heavy metals

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Abstract. Feed products obtained from rapeseed oilseeds are increasingly used in feeding young animals and in feeding dairy cows. With the introduction into production and use of non-erucic, low-erucic (two-zero, zero) and without glycosinolates in the seeds of spring and winter grape varieties in the Kaliningrad, Lipetsk, Leningrad, Novgorod, Moscow regions, in the Urals., in Western and Eastern Siberia, in Poland. This study is devoted to a fundamentally new technological solution in one closed cycle of industrial production and processing of rapeseed oilseeds with their deep freezing followed by extrusion, feed products with high antioxidant. Antitoxic and sorption properties were obtained to increase the ecological and nutritional value of milk of cows during lactation decay in 8-9 months of their pregnancy. During this period, the production cycle in the body of cows and milk accumulate heavy and toxic metals that adversely affect the metabolism, health and quality of milk during silage type of feeding. The components studied have improved the taste and smell of rations, purify milk and the body from heavy metals. Used different doses of seeds, oil and paste in the diets of cows mixed with feed (after milking).

1. Introduction
Increasing productivity, improving the reproductive ability of cows, the chemical composition and environmental friendliness of dairy products can be achieved through the use of rapeseed components in the system of their nutrition, obtained after pre-freezing of seeds (oilseeds) by cold, with their subsequent extrusion [1, 2, 5].

Finished rapeseed components (seeds, seed paste, rapeseed oil), passed all stages of their preparation in one closed cycle of industrial production and processing in deep freezing of raw materials showed high antioxidant, antitoxic and sorption properties. There is a scientific interest to the unique properties complex purpose in rapeseed components. The practical importance is due to especially in the production of feed in specialized shops and enterprises of the country, and to improve the usefulness of animal feeding diets for missing nutrients and biologically active substances in the body [2, 4].

The use of rapeseed oil components in seeds after deep-frozen, pasta and canola oil from the simultaneous variety or varieties as a natural, supplementary feed product without including them in
the chemical, biochemical and other processes of influence, with their favourable properties in the composition of diets cause the body to cows in physiological the most intense periods of the production cycle (8-9 months of pregnancy) functional activation of the whole digestive, immune, circulatory systems, improves carbohydrate and fat, protein metabolism. These data are consistent with the studies of several authors [5, 6, 8].

Rapeseed paste in the form of a fat-protein concentrate does not clump, does not accumulate in various nodes and connections, has a high degree of flowability in the production of dry feed mixtures and compound feeds for farm animals. It has a high energy nutritional value (in 1 kg of pasta-1,24-1,39 EKE), it contains a sufficient amount of protein, fat, vitamins, amino acids, carbohydrates, calcium, has high aromatic and spicy qualities, a stable smell of fresh green cucumbers and cookies [3, 6].

Rapeseed components (classes, Hannah Quint and Solux) with high antioxidant, antitoxic and sorption properties determine feeding cows. These components, along with the increased activity of cow enzyme systems, improve detoxification functions of the liver and the whole organism, increases the functional activity of the mammary gland. The results are the increase in milk production, metabolic processes and improving the environmental performance of products [7, 9]. As a result, production increasing of rapeseed and feed additives in the region.

With the use of different doses of rapeseed components in the diet, it became possible to significantly reduce the degree of contamination of milk and the body of cows in 8-9 months of pregnancy from heavy and toxic metals. It became possible to increase the metabolism of organisms, their retention during the busy period of the production cycle [7, 8, 9].

Inclusion in the diet of rapeseed components had a positive impact on improving productivity, metabolism, body protein, lipids, vitamin E (reproduction), B vitamins, carbohydrates, calcium, amino acids in cows in 8-9 months of pregnancy in a year-round stall [6,7].

Scientific interest and practical significance are in the complex use of vitamin E, b vitamins, polyunsaturated fatty acids, essential amino acids, linoleic acid, nitrogen, mineral macro-and microelements in the composition of rapeseed components of the diets of cows with high taste qualities of milk [2, 9].

Carriers (sources) of antioxidant and sorption properties of dual-use, contained in their composition of diets can clean not only products but also the body of cows from heavy metals [5,7,10].

The study aimed to study the effect of antioxidant, antitoxic and sorption properties of rapeseed components in the diets of cows at 8-9 months of pregnancy on the environmental friendliness of milk, metabolism and retention of heavy toxic metals in the body.

The objectives of the study were:
- to establish the optimal dose of rapeseed components in the diets of cows for 8-9 months of pregnancy;
- to study the indicators of productivity, digestibility of nutrients in diets and retention of heavy metals in the body.

2. Material and methods of research

Studies were conducted on milk cows of black-and-white breed at the age of 2-3 lactation with livestock of 10 cows in each group on the principle of pairs-analogues. The productivity of cows for the previous lactation was more than 6000 kg of milk, the type of feeding-silage and hay. The feeding rations of cows corresponded to the generally accepted norms of feeding (M. RASKHN, 2003). Physiological and scientific-economic experiments were carried out based on the experimental farm of the Novgorod agrarian technical College following generally accepted methods (A. I. Ovsyannikov, 1976) [3].

Groups of animals (control and experimental) corresponded to live weight, breed, breed, age in lactations and insemination period. Physiological (balance) experience was conducted against the background of scientific and economic, in the last ten days of research accounting (main) period, three heads in each group.
During the accounting period, samples of feed, feed additives, drinking water, faeces, urine, milk were taken daily with their simultaneous weighing on the scales. Average samples (10% by weight) per day from each cow in the groups were allocated for the research. To avoid nitrogen losses in urine 10% HCl of 10% concentration was added, 10 ml toluene was added in faeces. The account of actually consumed forages and their remains was carried out daily. They were keeping cows tethered with fixed feeders in separate stalls – storage of milk bioassays-in refrigerators under generally accepted requirements.

Faeces were stored in desiccators with lids, and urine – bottles of 20 l with the inclusion of 2-4 crystals of thymol. Faecal samples were dried in drying cabinets at first to 60-65°C, then at 100-105°C (hygroscopic moisture state) – crude ash-byashing in a muffle furnace at a temperature of 500-700°C to a constant mass.

All digital material is biometrically processed according to standard programs of variational statistics with the determination of student's reliability criterion (N. A. Plokhinsky, 1970). The experiment was carried out according to the following scheme (Table 1).

| Group of cows | Number of animals in the group, heads | Age in lactations | Feeding conditions |
|---------------|--------------------------------------|-------------------|-------------------|
| Control       | 10                                   | 2-3               | Basic diet (BD)   |
| I experimental| 10                                   | 2-3               | BD+30 g/head rape seed |
| II experimental| 10                                  | 2-3               | BD+50 g/head rape seed |
| III experimental| 10                                 | 2-3               | BD+80 g/head rape seed |
| IV experimental| 10                                  | 2-3               | BD+30 g/head paste of rape seeds |
| V experimental| 10                                   | 2-3               | BD+20 ml rape seed oil |
| VI experimental| 10                                 | 2-3               | BD+30 ml rape seed oil |
| VII experimental| 10                               | 2-3              | BD+40 ml rape seed oil |

Cows with attenuation of lactation control and experimental groups were given the same amount of hay (7.5 kg), silage from perennial grasses (15.2 kg), feed (2.4 kg), salt (50 g) and feed precipitate (60 g). The animals of the experimental groups were fed rape seeds (after freezing) additionally in a mixture with feed: the first – 30 g, the second – 50 g, the third – 80 g, the fourth – 30 g of paste. Rapeseed oil mixed with feed was given to the animals of the fifth experimental group – 20 g, the sixth – 30 g and the seventh experimental group – 40 g per head per day. The diets of cows contained 94.7 g of digestible protein per 1 EKE, 19.8% fibre, 26-2, 8% fat (from the dry matter). 1 kg DM of the diets contained 0.81 EKE exchange of energy. The Ca: P ratio ranged from 1.70:1 to 1.72:1.

The concentration of heavy metals in the diet control group was 353,171 mg. In experimental groups, it ranged from 353,171 mg (VII experienced) to 353,366 mg (III experimental group) depending on the use of various types of canola components.

The content of minerals, heavy toxic metals in the samples studied in the Central chemical laboratory of PJSC “Acron” Novgorod region. The vitamin value of milk cows on the device “Drops” at the epidemiology centre of Rospotrebnadzor for the Novgorod region, the amino acid composition of milk, forage and blood on the instrument Nd-1200 F in the testing centre of FSBI/IN the FILAMENT P (Sergiev Posad-11 Moscow region).

3. Research results and discussion
The use of various rapeseed components in the diets of cows during lactation attenuation led to an increase in the intensity of heavy metals release through the gastrointestinal tract. The use of rapeseed paste (in the form of a fat-protein concentrate) in the diet, containing antioxidant, sorption properties,
cause, along with the improvement of metabolic processes, a decrease in the Toxicological effect on the liver and on the body level. At the same time:

- significantly increased the intensity of excretion of heavy metals (in total) through the gastrointestinal tract (19.4%, P<0.001);
- significantly increased the intensity of excretion of heavy metals (in total) through the kidneys (71.0%), not only with the use of paste but also rapeseed seeds at a dose of 50 g per head (2.9 times) and rapeseed oil (5.0 times).

The inclusion in the diet of rapeseed components with antioxidant and sorption properties increase the sensitivity of the olfactory organs in humans and animals because a powerful effect is improvers of taste and smell of fresh milk. The results show improving the functional activity of the digestive system, appetite, palatability of feed. The consequence is the concentration of polyunsaturated fatty acids, fat, energy in the cow body, which positively influenced the growth of milk productivity by 11.4% compared to the control variant (Table 2).

With the use of rapeseed oil in the diet at a dose of 40 g per head per day, the average daily milk yield of 4% fat compared to the control increased by 2.5%.

The use of rapeseed components in the diets of cows allowed realizing the environmental friendliness of milk production entirely caused a decrease in their body Toxicological effects on organs and tissues, improved overall health, protein, lipid, carbohydrate, amino acid, vitamin and mineral metabolism. In the cows' organism in the critical period of lactation, a decrease in the intensity retention (accumulation) of heavy metals in the breast. This process has a positive effect on increasing the average daily milk yield. Their concentration in milk during the WTO as the application of rapeseed (after frost) was 0.57±0.03 mg/kg vs of 8.83±1.26 mg/kg in the control variant.

In the case of inclusion in the diet of 30 g per head of rapeseed oil, it is equal to 0.93±0.08 mg/kg, and seed paste (fat – protein concentrate – 1.53±0.14 mg/kg). Inclusion in the diet of 40 g/head of oil led to the total retention of heavy metals in milk – 7.97±0.66 mg/kg, which is slightly below the control level.

The use of rapeseed paste and oil (20 g/head) caused not only an improvement in metabolic processes of the body but also decreased Toxicological effect on the liver. There was a functional activity of the breast with an increase in the activity of enzyme systems that catalyze the sequential transfer of hydrogen atoms or electrons from the initial donor to the final acceptor, that is, in the respiratory chain (catalase, peroxidase, cytochromes). The studied heavy and toxic metals participated in redox reactions and immunological interactions.

Application in diets of subjects with antioxidant and canola sorption components have improved physiological and biochemical status of cows. Increase milk production and decrease of the most toxic metals localization (cadmium, mercury) in milk and their total content occur. Values allowed adjusting the optimal distribution when use rape seeds in doses of from 30 to 80 g per head: iron bivalent>zinc>copper>lead>mercury>arsenic>cadmium. In this case, the redox potential has improved.

When included in the diet of 30 ml of rapeseed oil, the content of heavy metals in the milk of cows is located in the following sequence (in % of their amount): ferrous iron, zinc, copper, lead, mercury, arsenic, cadmium. The share of iron in milk (at different doses of rapeseed oil) accounted for 37.6-76.7%. The predominant iron content in milk is established when feeding and other rapeseed component-paste.
Table 2. Effect of the use of rapeseed components in the diets of cows on milk production in 8-9 months of pregnancy

| Group of cows | Average daily milk yield, kg | Change in milk yield of 4% fat content in the accounting period (%) |
|---------------|-------------------------------|-------------------------------------------------------------------|
|               | Natural fat content | 4% fat content | Natural fat content | 4% fat content | Preparatory period | To the control group |
| Control group (BD) | 11.1±0.19 | 10.54±0.18 | 12.3±0.23 | 11.68±1.03 | 110.8 | - |
| I experimental group (BD+30 g/head rapeseed) | 11.2±0.16 | 10.64±0.20 | 12.5±0.35 | 11.87±1.27 | 111.5 | 101.6 |
| II experimental group (BD+50g/head rapeseed) | 11.3±0.40 | 10.73±0.35 | 12.7±0.29 | 12.06±1.19 | 112.4 | 103.2 |
| III experimental group (BD+80g/head rapeseed) | 11.4±0.26 | 10.83±0.43 | 12.8±0.43 | 12.16±1.24 | 112.3 | 104.1 |
| IV experimental group (BD+30 g/head paste of rape seeds) | 11.7±0.41 | 11.11±0.25 | 13.7±0.61* | 13.01±1.33 | 117.1 | 111.4 |
| V experimental group (BD+20 ml rapeseed oil) | 11.2±0.38 | 10.64±0.31 | 12.4±0.37 | 11.78±1.35 | 110.7 | 100.8 |
| VI experimental group (BD+30 ml rapeseed oil) | 11.3±0.80 | 10.73±0.45 | 12.5±0.49 | 11.87±0.93 | 110.6 | 101.6 |
| VII experimental group (BD+40 ml rapeseed oil) | 11.3±0.64 | 10.73±0.27 | 12.6±0.55 | 11.97±0.86 | 111.5 | 102.5 |

*p<0.05

4. The effect of rapeseed components in feeding cows 8-9 months of pregnancy on the digestibility of nutrients diets

Feeding cows various rapeseed components causes in their body in the most physiological stressful period of the production cycle functional activation of the entire digestive, hormonal and hematopoietic systems. This feeding improves the state of carbohydrate - fat - protein, amino acid and mineral metabolism. This result is manifested in increasing the digestibility of nutrients diets with the addition of:

1. Rape seeds after freezing:
   - organic substances – 0.8-1.9%, dry matter – 1.1-1.7%, protein – 1.2-2.5%, fat – 0.5-1.4%, nitrogen-free extractive substance – 0.1-3.9%, fiber-0.6-1.4% (p<0.05);
2. Rapeseed paste:
   - fat-2.6%, protein-2.9%, fiber-6.8% (p<0.001);
3. Rapeseed oil:
   - protein – 2.9-3.4% (p<0.001), fat-0.2-1.8%, organic matter-0.2-1.8%, dry matter-0.1-3.1%, nitrogen-free extractive substance – 1.6-2.3%;

The level of nitrogen retention in the body when used in diets:
- rapeseed after freezing – from 6.9 to 12.0 g (control 6.9 g);
- paste from rapeseed-9.5 g (control 6.9 g);
- rapeseed oil – from 10.1 to 12.3 g (control 6.9 g);

The level of calcium retention in the body when used in diets:
- rapeseed after freezing – from 17.73 to 21.35 g (control 16.82 g);
- paste from rapeseed – 14.74 g (control 16.82 g);
- rapeseed oil – from 12.96 to 16.46 g (control 16.82 g);

Phosphorus retention level in the body when used in diets:
- rapeseed after freezing – from 5.13 to 8.53 g (control 6.08 g);
- paste from rapeseed – 3.66 g (control 6.08 g);
- rapeseed oil – from 2.60 to 9.52 g (control 6.08 g).

5. Exchange of heavy metals by the body of cows when used in the diet of rapeseed components

Against the background of the silage-hay type of feeding of cows with the use of rapeseed components (seeds, paste and oil) it was necessary to study the metabolic processes, metabolism of heavy metals occurring in their body.

Based on experimental studies obtained in scientific, economic and physiological (balance) experiments, the intensity of retention and excretion of heavy metals from the body of cows in 8-9 months of pregnancy was revealed. It should be borne in mind that these indicators characterize the degree of their accumulation and excretion from the body, inherited to some extent from the cows themselves throughout the lactation activity.

Table 3 shows the balances (±) of heavy metals in cows at 8-9 months of pregnancy of cows.

| Indicator               | Control group (BD) | I experimental group (BD+30 g/head rapeseed) | II experimental group (BD+50g/ head rapeseed) | III experimental group (BD+80g/ head rapeseed) | IV experimental group (BD+30 g/head paste of rape seeds) | V experimental group (BD+20 ml rapeseed oil) | VI experimental group (BD+30 ml rapeseed oil) | VII experimental group (BD+40 ml rapeseed oil) |
|-------------------------|--------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|------------------------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|
| Zinc                    | -279,73            | -289,39                                    | -347,12                                    | -399,20                                    | -459,87                                        | -320,09                                    | -352,03                                    | -349,8                                      |
| Copper                  | -245,74            | -311,93                                    | -336,27                                    | -235,59                                    | -312,02                                        | -320,62                                    | -422,20                                    | -462,20                                    |
| Lead                    | -133,533           | -216,003                                   | -214,559                                   | -261,511                                   | -184,311                                       | -90,108                                    | -95,98                                     | -135,624                                   |
| Cadmium                 | -127,17            | -138,685                                   | -135,112                                   | -151,207                                   | -120,494                                       | -106,792                                   | -95,923                                    | -118,06                                    |
| Arsenic                 | 0.034±0.00         | -0.333                                      | 0.024±0.01                                 | -0.10                                      | -0.078                                         | -0.145                                     | -0.120                                     | -0.118                                     |
| Mercury                 | -1.65±0.11         | -0.006                                      | -0.318                                     | -0.272                                     | -0.094                                         | -0.05                                      | -0.160                                     | -0.110                                     |
| Iron                    | -87,904            | -33,763                                     | -85,633                                    | -30,30                                     | -39,69                                         | -10,928                                    | -7,075                                     | -199,02                                    |

* Heavy metal balance refers to the level of excretion or accumulation in the body.

The use of rapeseed components with antioxidant and sorption properties and containing selenium, vitamin E and B vitamin in cows diet in the 8-9 months of pregnancy had a positive impact not only on the level of milk production and reducing the degree of contamination of milk by heavy metals.
One of the remarkable properties of these mixtures is improving the digestibility of diets nutrients, nitrogen, calcium and phosphorus retention and improvement of physiological – biochemical status. These results are reflected:

- the increase in purity of the body of cows from the degree of retention of heavy and toxic metals (Zn, Cu, Pb, Cd, As, Hg);
- favourable distribution in milk.

The inclusion of rapeseed components (seeds after freezing, rapeseed paste, rapeseed oil) in the diets of cows with the attenuation of lactation (8-9 months of pregnancy) caused an increase in metabolic processes of the body. The dosed use of rapeseed components in diets at the silage-hay type of feeding improves taste and smell of fresh milk of cows on farms and complexes, increases the sensitivity of smell in office rooms, appetite and palatability of forages, the concentration of polyunsaturated fatty acids, fat, protein, vitamins in an organism. These properties are especially important in the conditions of the year-round way of cow maintenance.

Rapeseed feed products subjected to cold (deep freeze) followed by extrusion, contributed to improving the taste and smell of fresh milk in 8-9 months of pregnancy of cows, increase the intensity of heavy metals (in total) through the gastrointestinal tract, kidneys, contributed to the adjustment in their optimal distribution, in particular when included in the diet of rapeseed in doses of 30 to 80 g per head per day: iron>zinc> copper>lead>mercury>arsenic>cadmium.

Rapeseed components in the diet helped to increase the digestibility of organic substances. The dosed use of these feed additives in the silage-hay type of feeding of cows in the conditions of the year-round method of keeping allowed clearing their body of retention of heavy and toxic metals.

When using rapeseed components in diets, the balance of mercury in the body of cows was negative and ranged from minus 0.006 mg to minus 0.318 mg versus 1.65±0.11 mg in the control variant. In the body of animals of the experimental group with the addition to the diet of 20 g of rapeseed oil per head per day, the mercury balance was 0.05 mg. The Positive balance of mercury in their body is due to inheritance from the cows themselves in the previous lactation. At the specified dose of rapeseed oil in the diet, the body did not adapt and did not have a significant effect on the excretion of mercury.

6. Conclusion

When processing rapeseed oil seeds with imported liquid pesticides in the summer (twice) from various pests (insects), the agronomic service and their specialists systematically carry out purposeful work in order to preserve the yield of rapeseed seeds.

Canola, rapeseed and green fodder components in a mixture with other feed rations needed to feed the cows only after milking. In such cases, the toxicological effect of rapeseed components on the body and dairy products is significantly reduced.

The use of rapeseed component in the diet of cows in a busy period of lactation in the form of oil at a dose of 20 g per day compared with the control option allowed reducing the balance of mercury in the body by 33 times. Moreover, with subsequent doses of oil, the body adapted in the case of its inclusion in the diet after milking cows, in particular with increased antioxidant activity of vitamin E and selenium.

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