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# Influence of using seeds of flax and raps in cow rates on the quality of milk and dairy products

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## Abstract

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The article presents the results of scientific and economic experience of determine of effectiveness of using flax and rape oilseeds passed through the press in feeding high-producing cows. Studies have established that first-calf cows, who received rape seeds in their diet, outperformed their counterparts in terms of milk productivity by 6.2% and 2.3%.

In the production of yoghurt, the duration of fermentation of milk obtained from cows which used rape seeds in ration was 3 hours 18 min, that is 37 minutes less compared to the same indicator of the control group ($P \geq 0.95$). The product obtained from the milk of the cows of the experimental group had less whey during storage. The degree of syneresis was 26.1-28.4%.

The use of flax seeds adversely affected the technological properties of milk in production of cheese. Milk was poorly folded by rennet enzyme, the clotting time was 125.7 minutes, there was 119.9 mg% of calcium content in the milk, it is low content (the standard is not less than 125 mg%), milk consumption per 1 kg of cheese was 9.1 kg (in control 8.4 kg), while the cheese was not plastic in consistency, it did not hold the shape well. The milk obtained from cows feeding with flax seeds is not recommended for production of hard cheeses.

*Keywords:* cows; feeding diets; milk quality; chemical composition; technological properties; yogurt; cheese; cottage cheese

## Introduction

In conditions of deficiency of food and fodder protein in Russia and in the world, the problem of expanding its raw materials base due to under-utilized plant raw materials, as well as secondary products obtained during the processing of oil plant seeds (Loshkoyomnikov and Burlakova, 2009; Kozinets et al., 2011) is a topical issue. The partial replacement of concentrates by using of oilseeds (protein content up to 20% and fat more than 40%) is promising. It is advisable usage of such feed additives as rape seeds of 00-type varieties and oilseed of flax.

There is an opportunity to meet the needs of animals in these types of feed in Russia. In the structure of agriculture in 2017, sowing of oil crops such as flax and rape, amounted to 566 and 1020 thousand ha respectively. In the Udmurt Republic, according to the data of the Ministry of Agriculture and Food in 2016, the total harvesting area of oilseeds (fiber flax, oilseed, rape) was 6,206 hectares. The harvest of oilseeds amounted to 3166.1 tons from all cultures. Availability of raw material base ensures the expansion of assortment of energy-saturated and protein foods and contributes to the reduction in costs of diets for feeding cows (Kislyakova and Abasheva, 2016; Kislyakova et al., 2017).

Seeds of flax and rape, oilcakes and oilmeals are excellent protein feed for cattle. Feeding rape cake to cattle increases the protein and volatile fatty acid content in the scar tissue, increases the number of ciliates and reduces the level

of ammonia (Todorov et al., 2016; Nedelkov et al., 2017).

Flax seeds are rich in polyunsaturated fatty acids, which positively influence the basic processes of vital activity of the body. They contain up to 10% of mucous substances that are not digested by monogastric animals, but can be destroyed by rumen microorganisms. Mucous substances in water form a sticky mucus, under the influence of which the chyme is retained longer in the rumen of ruminant animals. This provides better conditions for the microbial transformation of the retained scar (Šípalová et al., 2016).

The analysis of scientific publications confirms the positive effect of the use of flax and rape cakes on the productivity of cattle. However, there is insufficient information on the impact of the use of flax and rape oilseeds on the quality of milk and dairy products. In this regard, our research carries a scientific novelty, practical significance and they are relevant.

## Material and Methods

The aim of the research was studying of effectiveness of the interchange of sunflower meal in the rations of cows to the flax and rape oilseeds for the technological properties of milk and the quality of the obtained products.

Experimental studies were carried out on the basis of a breeding farm for the cultivation of cattle of the Black and Motley breed of JSC Uchkhoz Iyulskoye of Izhevsk State Agricultural Academy. Experimental animals were selected by para-analog method. There were selected 27 first-calf cows and 3 groups were formed. The animals of the control group received a basic diet, which included a sunflower cake as a protein component. In the rations of the cows of the first experimental group, 30% of the sunflower cake (according to the content of crude protein) was replaced with flax oilseeds, in the rations of the analogues from the second experimental group it was replaced with rapeseed. In both cases the oilseeds were passed through oil-press.

## Results

The quality of milk is crucial in the production of dairy products (Beryzkina and Vologzhanina, 2016; Kislyakova and Berezkina, 2016; Beryzkina and Korepanova, 2017). The introduction of flax and rape seeds into the diet of cows had an influence on milk productivity, milk quality and technological properties. The first-calf cows which received rape seeds (the second experimental group) in the diet exceeded their analogues in terms of milk productivity. During the first 100 days of lactation, their average daily milk yield was 22.2 kg on average per head, which is 6.2 and 2.3% more than in the case of peers from the control group and the first experimental group respectively. The chemical composition of the milk of the experimental animals is shown in Table 1.

Dry matter and nonfat milk solids are the final indicators of milk composition. In these studies, the dry matter content in milk was 11.7-11.9%, there was no significant difference. The content of nonfat milk solids in the milk of the animals under study is at the level of 8.08-8.33%. In the milk of first-calf cows of the second experimental group that received rapeseeds, a higher content of nonfat milk solids was found compared with the control group analogues by 0.16% (P≥0.95) and compared to the milk of the cows of the first experimental group by 0,25% (P≥0.99).

The fat content in the milk of the first-calf cows of the experimental groups was 3.60-3.61%, which is 0.08 -0.09% lower than the control group (the difference is not significant).

The use of oilseeds in the feeding of first-calf cows had a positive effect on the mass fraction of protein in milk. The values of this indicator for first-calf cows of the first and second experimental groups were 2.93% and 2.97% respectively, which is higher for 0.1% and 0.14% respectively (P>0.999) than in the control group.

**Table 1. Chemical composition of milk of first-calf cows, X ± mx**

| Index | Groups | | |
|---|---|---|---|
| | Control | First group | Second group |
| Moisture content | 88,1 ± 0,21 | 88,3 ± 0,18 | 88,1 ± 0,23 |
| Mass fraction of dry substance | 11,9 ± 0,04 | 11,7 ± 0,05 | 11,9 ± 0,02 |
| Mass fraction of nonfat milk solids | 8,17 ± 0,07* | 8,08 ± 0,04 | 8,33 ± 0,06** |
| Mass fraction of fat | 3,69 ± 0,04 | 3,60 ± 0,05 | 3,61 ± 0,06 |
| Mass fraction of protein | 2,83 ± 0,01 | 2,93 ±0,02*** | 2,97 ± 0,02*** |
| among other, Casein | 2,33 ± 0,14 | 2,35 ± 0,12 | 2,15 ± 0,11 |
| Serum proteins | 0,64 ± 0,05 | 0,58 ± 0,04 | 0,68 ± 0,03 |
| Mass fraction of lactose | 4,68 ± 0,03 | 4,50 ± 0,02 | 4,70 ± 0,03*** |
| Mass fraction of mineral substances | 0,66 ± 0,01 | 0,65 ± 0,01 | 0,66 ± 0,01 |

*Note*: * P≥0.95; ** P≥0.99; *** P≥0.999

**Table 2. Quality of sour-milk clot**

| Index | Requirements of GOST 31981-2013 | Groups | | |
|---|---|---|---|---|
| | | Control | First group | Second group |
| Appearance and consistency | Homogeneous, moderately viscous | Homogeneous structure of a rather viscous | | |
| Taste and smell | Sour-milk, without foreign flavors and smells | Clean, sour-milk with a pronounced taste and aroma | | |
| Colour | Milky white, uniform throughout the mass | White, uniform throughout the mass | | |
| Acidity | from 75 to 140 | 81,0 ± 0,21 | 81,4 ± 0,3 | 81,2 ± 0,4 |
| Ripening time | 3-4 h | 3-55 ± 0,1 | 3-45 ± 0,2 | 3-18 ± 0,1* |
| Viscosity of the bunch | – | 1,62 ± 0,4 | 2,48 ± 0,5 | 2,55 ± 0,3 |
| Degree of syneresis | – | 31,1 ± 1,1 | 28,4 ± 1,1 | 26,1 ± 1,2** |

*Note*: * P≥0.95; ** P≥0.99

The lactose content in the milk of the cows of the studied groups was 4.5-4.7%. The maximum indicator was found in the second experimental group. The lactose content in their milk is greater by 0.2% compared to the analogues of the first experimental group (P≥0.999). The level of mineral substances in milk was within 0.65-0.66% (the difference is not significant).

Assessment of organoleptic, physico-chemical and microbiological indicators of milk quality was made as part of the study, as well as an assessment of technological properties and control production of yoghurt, cottage cheese and cheese.

According to the organoleptic indicators, the milk of first-calf cows in the study groups corresponded to the requirements of the Technical Regulations of the Customs Union «On the safety of milk and dairy products». The density of milk was in the range of 1027.5-1028.1 kg/m$^3$. The indicators of total bacterial contamination and the content of somatic cells in raw milk did not differ significantly. No inhibitory substances were found.

Milk was soured using a symbiotic yoghurt culture consisting of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* of subspecies *bulgaricus* (thermophilic streptococcus and Bulgarian bacillus) to determine the suitability of milk for yoghurt production. The souring was carried out in a thermostat at a temperature of 40-42°C until a clot was formed with an acidity of 80°T. The average parameters for assessing the quality of the sour-milk bunch are presented in Table 2.

According to the organoleptic indicators, produced yogurt was in full compliance with the requirements of the normative and technical documentation. The consistency of the product is uniformly moderately viscous, the taste of sour milk is well expressed, and the color is white uniform throughout the mass.

On the physical and chemical parameters, the quality of yogurt had some differences. Usage of rapeseeds in the diet had a positive effect on the duration of milk ripening. Thus, the milk mowing time in the second experimental group was 3 hours 18 min, which is significantly (P≥0.95) less compared to the same indicator of the control group for 37 min or 15.7%. Produced yoghurt from the milk of the first-calf cows of the second experimental group was characterized by a thicker consistency, the viscosity was 2.55 Pa/sec, which is higher in comparison with the control group analogues by 0.93 Pa/s and the first experimental group by 0.07 Pa/sec (the difference is not statistically significant).

A product made from the milk obtained from cows which used oil seeds less separates whey during storage. The degree of syneresis in the first experimental group was 28.4%, and in the second experimental group - 26.1%, which is lower in comparison with the control group by 2.7% and 5.0% (P≥0.99) respectively.

The next step was the control production of cottage cheese by the acid method. Cottage cheese, produced from the milk of experimental animals, had a soft rag-like consistency, pure sour-milk taste and smell, the color was white uniform throughout the mass. Based on the results of the tasting evaluation, all samples received a total score of 14.5 to 14.8. The highest score was obtained from cottage cheese, produced from the milk of the second experimental group, as it had a more pronounced taste and aroma.

According to the physicochemical index, cottage cheese fully complies with the requirements of normative technical documentation (Table 3). The mass fraction of fat was in the range from 5.1% to 5.2%, the mass fraction of moisture was from 74.1% to 74.3%. The milk consumption per 1 kg of curd was from 6.0 kg to 6.6 kg. The smallest milk consumption per 1 kg of product was established in the second experimental group.

**Table 3. Physicochemical indicators of cottage cheese**

| Index | Requirements of GOST 31453-2013 | Group | | |
|---|---|---|---|---|
| | | Control | First group | Second group |
| Mass fraction of fat, % | Not less than 5.0 | 5,1 ± 1,4 | 5,2 ± 1,9 | 5,2 ± 1,2 |
| Mass fraction of moisture, % | Not more than 75.0 | 74,1 ± 4,8 | 74,3 ± 4,1 | 74,1 ± 5,1 |
| Milk consumption per 1 kg of cottage cheese | – | 6,6 | 6,2 | 6,0 |

Comparative characteristics of cheese suitability of milk of experimental cows and compliance with the requirements of normative and technical documentation are presented in Table 4.

The use of flax and rape seeds in diets of first-calf cows had a positive effect on the cheese suitability of milk. The highest calcium content was observed in the milk of first-calf cows of the second experimental group (138.8 mg%). This indicator is greater than in the milk of animals of the control and first experimental groups by 16.5 mg% and 18.9 mg% respectively. The content of somatic cells in the milk of all groups was within 125.7 to 134.6 thousand/ml, which corresponds to the requirements of normative and technical documentation.

All obtained milk was rennet-flaccid. When feeding the rapeseed, the coagulation time was 57.6 min. The milk of the control animals and the second experimental group was folded in 87.1 and 125.7 min respectively. The duration of coagulation of the milk of the cows of the second experimental group was significantly less than in the control group by 29.5 min (P>0.95) and the first experimental group by 68.1 min (P≥0.999). The duration of coagulation of the control group cows was significantly (P≥0.95) less than the milk of the analogues of the first experimental group for 38.6 min.

The largest diameter of casein micelles was observed in the milk of the first-calf cows of the second experimental group. They exceeded their control group analogues by 18.1 Å, compared with cows of the first experimental group - by 32.4 Å (the difference is not valid). The best result of weight micelles of casein was obtained from the first-calf cows of the second experimental group. This figure was higher than in the control group by 3.3 million tons of mammal mass, and in comparison with the milk of the second group - by 6.6 million units of mammal mass (6.2%). According to the indicators milk of animals of all groups considered to be corresponded to the average values for black and motley breed.

Cheese “Fresh Table” was produced in the course of

**Table 4. Evaluation results of milk wetness**

| Index | Requirements for raw milk | Group | | |
|---|---|---|---|---|
| | | Control | First group | Second group |
| Mass fraction of protein, % | not less than 3,0 | 2,83 ± 0,01 | 2,93 ±0,02*** | 2,97 ± 0,02*** |
| along other, casein | not less than 2,7 | 2,33 ± 0,14 | 2,35 ± 0,12 | 2,15 ± 0,11 |
| Mass fraction of fat, % | not less than 3.4 | 3,69 ± 0,04 | 3,60 ± 0,05 | 3,61 ± 0,06 |
| Mass fraction of calcium, mg% | not less than 125.0 | 122,3 ± 13,4 | 119,9 ± 13,4 | 138,8 ± 9,4 |
| Density, Å | not less than 27,0 | 28,5 ± 0,3 | 27,8 ± 0,3 | 28,1 ± 0,2 |
| Acidity, º T | - | 19,1 ± 0,8 | 18,6 ± 0,8 | 19,1 ± 1,0 |
| Bacterial seeding, thousand/cm$^3$ | not more than 300 | до 300 | до 300 | до 300 |
| Number of somatic cells, thousand/cm$^3$ | not more than 500 | 134,6 ± 29,3 | 125,7 ± 33,2 | 128,3 ± 155,1 |
| Milk class by rennet-fermentation test | I-II | II | II | II |
| Time of rennet clotting, min | not more than 15,0 | 87,1 ± 9,2 | 125,7 ± 13,2 | 57,6 ± 7,4*** |
| Diameter of casein micelles, Å | 630 | 649,0 ± 9,8 | 634,7 ± 11,5 | 667,1 ± 12,3 |
| Weight of micelles of casein, mln. mol. masses | 106 | 110,1 ± 4,8 | 106,8 ± 4,1 | 113,4 ± 5,6 |

**Table 5. Physicochemical parameters of cheese “Fresh Table”**

| Index | Rate | Group | | |
|---|---|---|---|---|
| | | Control | First group | Second group |
| Mass fraction of fat in dry matter, % | 40 ± 1,6 | 40,8 ± 1,2 | 40,1 ± 0,8 | 40,4 ± 1,1 |
| Mass fraction of moisture, not more than % | 53 | 52,7 ± 2,0 | 52,9 ± 1,9 | 52,1 ± 1,4 |
| Milk consumption per 1 kg of cheese, kg | - | 8,4 | 9,1 | 8,7 |

the research. Degustation assessment showed that the maximum amount of points was obtained from cheese produced from the milk of cows control group (91 points). This sample was distinguished by a pronounced cheese taste, without foreign flavors and odors, the dough is white, delicate and plastic, the eyes are irregular in shape, and the crust is even. Cheese produced from milk of cows of the second experimental group received 88 points, and it had a moderately pronounced cheese taste and smell. The product, obtained from the milk of the analogues of the first experimental group, received the smallest number of points (80), because it had a slightly sour taste and smell, the dough was not plastic. Cheese produced from the milk of control group and the second experimental group can be attributed to the highest grade, and cheese obtained from the milk of animals of the first experimental group can be attributed to the first grade.

According to physical and chemical parameters, all samples of cheese completely correspond to the requirements of normative and technical documentation (Table 5).

The maximum yield of cheese was obtained from the milk of the animals of the control group, with milk consumption in amount of 8.4 kg per 1 kg of cheese. The milk consumption for cheese production in the first and second experimental groups was 9.1 and 8.7 kg respectively.

The use of flaxseeds and rapeseeds had a positive effect on the heat-resistance of milk. Thus, in the experimental groups, 96.7% of the obtained milk had the first group of thermal stability, whereas in the control group this index was 15.6%.

## Conclusions

Our research has shown that the usage of rapeseed in cows' diets increases milk production. The introduction of flaxseeds helps to increase the mass fraction of fat in milk and rapeseeds stimulate increasing the mass of protein. The use of oilseeds in feeding cows does not have a significant effect on the quality of cottage cheese. The duration of milk ripening increases during the production of yoghurt with the introduction of rapeseed into the diet. The use of flax seeds adversely affected the technological properties of milk in the production of cheese.

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