

## Alternative Sources of Protein in the Diets of Highly Productive Cows

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### ABSTRACT

The article presents the results of scientific and economic experience in determining the comparative effectiveness of the use of feed products based on safflower cake in cow feeding diets. The research was carried out in Uchkhoz Iyulskoye of the Izhevsk State Agricultural Academy (Votkinsky district, Udmurt Republic, Russia). Animals were selected into groups according to the principle of pairs of analogs. The influence on milk productivity, composition, and technological properties of cow milk was studied. The animals of the control group received the main diet, which included sunflower cake. One kg of sunflower cake was replaced with safflower cake for cows of the first experimental group, and with safflower cake with propylene glycol in the second experimental group. The replacement of sunflower cake with safflower cake and a feed product consisting of safflower cake and propylene glycol in the amount of 1 kg in the diets of highly productive cows contributes to an increase in milk productivity by 2.63 and 1.96 kg. The best effect is obtained when using safflower cake in its pure form. The positive dynamics of improving the quality characteristics of milk, in particular the mass fraction of fat, were noted. The introduction of safflower cake into the diet improves the technological properties of milk: the duration of rennet coagulation is reduced; the dynamics of increasing the diameter and mass of casein micelles is traced.

### Keywords

Dairy cattle breeding; Cows; Feeding ration; Cake; Safflower; Protein nutrition; Milk productivity; Milk quality.

### Introduction

Oilseeds in the Russian Federation have significant economic importance as a product for obtaining food and technical raw materials. Oils from sesame seeds, sunflower seeds, poppy seeds, mustard, safflower, flax, and cotton are used in human nutrition (Kislyakova, Achkasova, & Abasheva, 2017; Kislyakova, Lomaeva, & Achkasova, 2021; Radzhabov, Kurbanov, Gulov, & Dostov, 2018).

There are by-products – meal and cake at processing plants, after the extraction of vegetable oil. Their composition is rich in proteins, essential fatty acids, and minerals, so these products are valuable feed for animals and birds (Kislyakova, Vorobyeva, Kokonov, & Strelkov, 2019; Kugenev & Barabanshchikova, 1973; Lyubimov, Kislyakova, Achkasova, & Abasheva, 2018; Trukhachev, Ebzeev, & Barnev, 2010; Vologzhanina, Berezkina, & Vorobeva, 2018; Zoteev, Simonov, & Pisarev, 2016).

Recently, there has been an increased interest in the use of new types of cultivated plants that differ from the traditional ones in terms of a complex of signs and useful properties (Kislyakova et al., 2021; Lyubimov et al., 2018; Radzhabov, Dostov, & Kurbanov, 2019; Rechile, Shatskikh, Maslyuk, Shatskikh, & Masalimov, 2016; Soloshenko, Klimenok, & Nemzorov, 2017; Tukfatulin & Khetagurova, 2017). At the present stage, safflower cake is gaining popularity as a feed for cattle. This is due to a sharp increase in safflower production in the Russian

Federation and the cost of traditional cakes: sunflower and rapeseed. However, many farms still underestimate the use of this product in feeding farm animals (Filinskaya & Kevorkyan, 2018; Penkova & Mishina, 2012; Radzhabov et al., 2018; Ruppel & Olshanskaya, 2016). In this regard, our research on the effectiveness of the use of feed products based on safflower cake in cow feeding is relevant and practically significant.

The purpose of the research was to conduct a comparative assessment of the use of feed products with the use of safflower cake in feeding highly productive cows.

### **Materials and Methods**

The research was carried out in Uchkhoz Iyulskoye of the Izhevsk State Agricultural Academy (Votkinsky district, Udmurt Republic, Russia).

Animals were selected into groups according to the principle of pairs of analogs. The animals of the control group received the main diet, which included sunflower cake. One kg of sunflower cake was replaced with safflower cake for cows of the first experimental group, and with safflower cake with propylene glycol in the second experimental group.

The quality of milk was evaluated according to its physicochemical and technological properties. The following indicators were determined to assess the physicochemical properties of milk: the mass fraction of fat, the mass fraction of total protein, the mass fraction of nonfat milk solids on the Clover – M1 device, titrated acidity (titrimetric method according to GOST 3624-92).

To study the technological properties, the evaluation of the milk's cheese suitability was carried out according to the following indicators: rennet coagulability (according to the method of G.S. Inikhov and N.P. Brio (1971) and A.Ya. Dudenkov (1967); diameter and mass of casein micelles (according to the method of P.V. Kugenev and N.V. Barabanshikov (1973); milk class according to rennet-fermentation test (GOST 9225 – 84); thermal stability group according to alcohol test; the number of somatic cells on the "Somatos-M" device according to GOST 23453-90. The results obtained were processed by the method of variational statistics.

### **Results and Discussion**

A concentrate-haylage type of feeding is used in JSC "Uchkhoz July Izhevsk State Agricultural Academy" of Votkinsky district of the Udmurt Republic in feeding lactating cows. The share of concentrated feed accounts for 51% in the structure of the diet for dry matter in the phase of separation. At the time of the research, the basis of the diet was clover haylage and grain haylage. A large proportion of various cakes is used to balance the protein rations. These are sunflower, rapeseed, and flax. The use of several types of cake is justified since their combination in the diet contributes to the creation of an optimal balance of nitrogen in the rumen.

The diets of cows in terms of nutrition practically did not differ during the studies. According to the norms, they fully satisfied the cows' need for the given productivity in energy and protein. The main ratios of nutrients are close to the recommended norms. The content of metabolic

energy in dry matter is at the level of 10.9-11.0 Mass fraction of fat, the content of crude protein in dry matter is 15.7-15.9%.

The use of feed products based on safflower cake in cow feeding had a positive effect on milk productivity (Table 1).

**Table 1.** The main indicators of cow productivity for the accounting period,  $\bar{X} \pm m_x$

Indicator	Group		
	control	experimental 1	experimental 2
Average daily milk yield, kg	31.16±1.75	33.79±1.42	33.12±1.19
Mass fraction of fat, %	3.85± 0.25	3.98± 0.19	4.28± 0.26
Mass fraction of protein, %	2.86±0.01	2.82±0.04	2.88± 0.02

The results of control milking showed that replacing sunflower oilcake with safflower oilcake increases the average daily yield by 2.63 kg, and the use of safflower oilcake with propylene glycol by 1.96 kg. However, statistical data processing has shown that the difference in indicators is not significant, since the error of the average value is quite large. The positive dynamics of improving the quality characteristics of milk, in particular the mass fraction of fat, were also noted. Thus, when using safflower cake in its pure form, the mass fraction of fat increased by 0.13%, when using safflower cake with propylene glycol by 0.43%. There was no significant difference in the protein content in milk.

The study of the physicochemical composition of milk makes it possible to more fully assess the nutritional value, taste, and technological properties of the product. Table 2 presents the results of the analysis of the chemical composition and physical properties of the milk of cows of the experimental groups.

**Table 2.** Chemical composition and physical properties of milk of experimental cows,  $\bar{X} \pm m_x$

Indicator	Group		
	control	experimental 1	experimental 2
Mass fraction of dry matter, %	12.00 ± 0.04	12.06 ± 0.03	12.15 ± 0.05
Mass fraction of fat, %	3.79 ± 0.03	3.85± 0.03	3.95 ± 0.02
Mass fraction of nonfat milk solids, %	8.21 ± 0.05	8.21 ± 0.05	8.20 ± 0.05
Mass fraction of total protein, %	2.93 ± 0.01	2.94 ± 0.01	3.01 ± 0.01
Mass fraction of casein, %	2.37 ± 0.01	2.38± 0.01	2.42± 0.01
Mass fraction of serum protein, %	0.56 ± 0.01	0.56 ± 0.01	0.59 ± 0.01
Density, °A	26.45± 0.05	26.69± 0.05	27.22 ± 0.05
Acidity, °C	18.10 ± 0.02	18.11 ± 0.02	18.20 ± 0.02

There was a tendency to increase the dry matter content in milk against the background of the use of feed products based on safflower cake. There was no significant difference in the level of casein, but there was a tendency to increase its content in milk when using the studied feed products. The indicators of the nonfat milk solids in milk did not change significantly by group and corresponded to the requirements of the technical regulations. The density and acidity of milk were higher in cows of the second experimental group compared to animals of other groups.

The results of the study of the technological properties of cow milk, in which feed products based on safflower cake were used, are presented in Table 3.

**Table 3.** Technological properties of milk of experimental cows,  $\bar{X} \pm m_x$

Indicator	Group		
	control	experimental 1	experimental 2
Diameter of casein micelles, Å	673.47 ± 7.3	674.70 ± 9.4	653.10 ± 11.2
Mass of casein micelles, million units of molar weight	113.40 ± 6.93	116.33 ± 5.6	114.80 ± 4.9
Number of somatic cells, thousand/cm <sup>3</sup>	97.5 ± 8.14	90.0 ± 7.50	105.0 ± 7.02
Thermal stability group, assigned samples, %	Group 1 – 62.5 Group 2 – 37.5	Group 1 – 44.5 Group 2 – 55.5	Group 1 – 60 Group 2 – 40

It was found that the indicators of the milk's cheese suitability of cows of the first experimental group were better. Thus, the milk of cows of this group coagulated faster under the action of rennet enzyme – 12.73 minutes, the diameter and mass of casein micelles were larger and amounted to 674.70 Å and 116.33 million units of mol. mass, respectively.

The number of somatic cells in the milk of cows of the control and second experimental groups was 97.5 thousand/cm<sup>3</sup> and 105 thousand/cm<sup>3</sup>, respectively, the number of somatic cells was 90 thousand/cm<sup>3</sup> in the milk of cows of the second group. The thermal stability of milk corresponded to the first and second groups.

The rate of coagulation by the rennet enzyme shows the cheese suitability of milk (Table 4).

**Table 4.** The rate of rennet coagulation of milk of experimental groups,  $\bar{X} \pm m_x$

Indicators of cheese suitability	Group		
	control	experimental 1	experimental 2
Duration of rennet coagulation, min. total, including	12.84 ± 1.12	12.73 ± 1.32	13.03 ± 1.66
coagulation phase,	5.11 ± 0.47	5.12 ± 0.53	5.06 ± 0.52
gelation phase	7.73 ± 0.65	7.61 ± 0.79	7.97 ± 1.14

The most important indicator of milk's cheese suitability is the rate of coagulation of milk by rennet. Milk had slightly better coagulability in cows of the control and first experimental groups (12.84 min. and 12.73 min. respectively), and the milk obtained from the first-calf cows of the second experimental group (13.03 min.) was somewhat inferior in time to rennet coagulation. Also, in the milk of cows of the control and first groups, when the rennet enzyme is added to it, the shortest time for the formation of the coagulation phase is observed (5.11 min. and 5.12 min. respectively) and gelation phases (7.73 min. and 7.61 min. respectively). Thus, according to the results of our research, it was established that all milk was cheese-suitable. Replacing sunflower cake with safflower slightly shortened the duration of milk coagulation. The traditional protein feed additive in cow feeding diets is sunflower cake. Its cost is determined by the yield of sunflower, the quality of the product and varies greatly. In this regard, it is necessary to have alternative sources of protein in the diets of cows. Safflower cake is a valuable feed product that can be used both in mixtures and in pure form. The cake from unbroken safflower grains contains about 24-25% starch, 6-7% oil, and 19% protein fraction (Kadirbaev et al., 2013). In our studies, it was determined that the partial replacement of sunflower oilcake in the diets of highly productive cows with safflower oilcake, as well as with a feed product consisting of safflower oilcake and propylene glycol in an amount of 1 kg, contributes to an increase in milk productivity. The best effect is obtained when using safflower cake in its pure form. The positive dynamics of improving the quality characteristics of milk, in particular the mass fraction of fat, were also noted.

The results obtained are consistent with the previously conducted studies of I.V. Maslennikov and N.G. Korovin on the use of safflower cake in the diets of cows in pure form ("Sergeyevsky" APC and "Rassvet" APC, Udmurt Republic). However, the effect of using a feed product based on safflower cake with propylene glycol has not been confirmed. We assume that our research was carried out on a dairy herd with a productivity of over 8,000 kg. Consequently, such animals are more demanding of the energy saturation of the diet. We recommend partial replacement of sunflower cake with safflower in production conditions. The replacement can be made at the rate of 1 kg to 1 kg with a similar quality in terms of the crude protein content of 26%. When replacing sunflower cake of the best quality, we recommend recalculating the input rate of safflower cake according to the content of crude protein.

## Conclusion

Replacing sunflower cake in cow feeding diets with safflower increases the average daily yield by 2.63 kg, and the use of safflower cake with propylene glycol by 1.96 kg. There was a tendency to increase the mass fraction of fat and protein in milk against the background of the use of feed products based on safflower cake with propylene glycol.

The indicators of cheese suitability of milk of cows of the first experimental group, which received safflower cake, were better. The milk of cows of this group coagulated faster under the action of rennet enzyme – 12.73 minutes, the diameter and mass of casein micelles were larger and amounted to 674.70 Å and 116.33 million units of mol. mass, respectively.



## References

- [1] Dudenkov, A.Y. (1967). *Reference manual for laboratory assistants of butter and cheese factories*. Moscow, USSR: Pishchevaya promyshlennost.
- [2] Filinskaya, O. V., & Kevorkyan, S. A. (2018). Prakticheskie metody kontrolya polnotsennosti kormleniya vysokoproduktivnykh korov v usloviyakh sovremennogo kompleksa [Practical methods of monitoring the nutritional value of high-yielding cows in a modern complex]. *Vestnik APK Verkhnevolzhya*, 4(44), 30–36.
- [3] Inikhov, G. S., & Briio, N. P. (1971). *Methods for the analysis of milk and dairy products*. Moscow, USSR: Pishchevaya promyshlennost.
- [4] Kadirbaev, M. K., Erkebaev, M. Zh., Nekrasov, A. V., Sadvokasova, D. S., Mateev, E. Z., & Shakhov, S. V. (2013). Tekhnologicheskaya liniya proizvodstva saflorovogo masla [Safflower oil production line]. *Vestnik Almatinskogo tekhnologicheskogo universiteta*, 5, 16–20.
- [5] Kislyakova, E. M., Achkasova, E. V., & Abasheva, A. A. (2017). Molochnaya produktivnost korov cherno-pestroi porody pri skarmlivanii energo-proteinovoi dobavki iz mestnogo prirodnogo syrya [Milk productivity of black-and-white cows when feeding an energy-protein supplement from local natural raw materials]. In *Nauchno obosnovannye tekhnologii intensivatsii selskokhozyaistvennogo proizvodstva* [Scientifically based technologies for the intensification of agricultural production] (pp. 55–58). Izhevsk, Russia: Izhevsk State Agricultural Academy.
- [6] Kislyakova, E. M., Lomaeva, A. A., & Achkasova, E. V. (2021). *Pokazateli produktivnosti korov cherno-pestroi porody pri ispolzovanii v ratsionakh organicheskogo khroma* [Indicators of productivity of black-and-white cows when using organic chromium in diets]. Izhevsk, Russia: Izhevsk State Agricultural Academy.
- [7] Kislyakova, E. M., Vorobyeva, S., Kokonov, S., & Strelkov, I. (2019). Influence of using seeds of flax and raps in cow rates on the quality of milk and dairy products. *Bulgarian Journal of Agricultural Science*, 25(1), 129–133.
- [8] Kugenev, P. V., & Barabanshchikova, N. V. (1973). *Metodika postanovki opytov i issledovaniy po molochnomu khozyaistvu* [Methodology for setting up experiments and research on dairy farming]. Moscow, USSR: Russian State Agrarian University.
- [9] Lyubimov, A. I., Kislyakova, E. M., Achkasova, E. V., & Abasheva, A. A. (2018). *Energo-proteinovaya kormovaya dobavka na osnove semyan rapsa i zerna prosa* [Energy-protein feed additive based on rapeseed and millet grain] (Invention patent RU 2662767 C2, July 30, 2018. Application No. 2016118317 dated May 11, 2016). Izhevsk, Russia: Izhevsk State Agricultural Academy.
- [10] Penkova, I. N., & Mishina, O. Yu. (2012). Netraditsionnye zhmykhi kak sredstvo korrektsii kachestva i ekologicheskoi bezopasnosti produktsii skotovodstva v usloviyakh tekhnogeneza [Non-traditional oilcakes as a means of correcting the quality and environmental safety of livestock products in the conditions of technogenesis]. *Izvestiya Nizhnevolzhskogo agrouniversitetskogo kompleksa*, 4(28), 1–5.
- [11] Radzhabov, F. M., Dostov, M. T., & Kurbanov, M. M. (2019). Effektivnost ispolzovaniya vysokobelkovykh kormovykh dobavok v ratsionakh korov [Efficiency of using high-protein feed additives in cow diets]. *Vestnik Novosibirskogo gosudarstvennogo agrarnogo universiteta*, 1(50), 153–160.
- [12] Radzhabov, F. M., Kurbanov, M. M., Gulov, T. N., & Dostov, M. T. (2018). Molochnaya produktivnost vysokoproduktivnykh korov pri skarmlivanii im razlichnykh zhmykhov [Milk

- productivity of highly productive cows when feeding them various cakes]. *Vestnik Tadzhikskogo natsionalnogo universiteta. Seriya estestvennykh nauk*, 2, 239–244.
- [13] Rechile, M. N., Shatskikh, E. V., Maslyuk, A. N., Shatskikh, E. V., & Masalimov, A. D. (2016). Effektivnost vvedeniya rapsoвого zhmykha v ratsiony korov [The effectiveness of the introduction of rapeseed meal into the diets of cows]. *Molodezh i nauka*, 5, 80–86.
- [14] Ruppel, G. L., & Olshanskaya, G. P. (2016). Polnotsennoe kormlenie doinykh korov [Complete feeding of dairy cows]. In O. V. Shumakova, V. V. Aleshchenko, N. B. Gavrilova (Eds.), *Sovremennoe sostoyanie, perspektivy razvitiya molochnogo zhivotnovodstva i pererabotki sel'skokhozyaistvennoi produktsii* [The current state, prospects for the development of dairy farming and processing of agricultural products] (pp. 124–125). Omsk, Russia: Litera.
- [15] Soloshenko, V. A., Klimenok, I. I., & Nemzorov, A. M. (2017). Vliyanie kompleksa kormovykh dobavok novogo pokoleniya na khimicheskii sostav i tekhnologicheskie svoistva moloka u korov priobskogo tipa [Influence of a complex of feed additives of a new generation on the chemical composition and technological properties of milk in Ob-type cows]. *Kormlenie sel'skokhozyaistvennykh zhivotnykh i kormoproizvodstvo*, 10, 14–24.
- [16] Trukhachev, V. I., Ebzeev, M. M., & Barnev, V. N. (2010). Vliyanie skarmlivaniya raznykh istochnikov proteina na molochnyuyu produktivnost laktiruyushchikh korov [Effect of feeding different protein sources on milk production of lactating cows]. *Dostizheniya nauki i tekhniki APK*, 3, 53–55.
- [17] Tukfatulin, G. S., & Khetagurova, A. A. (2017). Produktivnost i kachestvo moloka korov pri skarmlivanii im kormov, vyrashchennykh po intensivnym tekhnologiyam [Productivity and quality of milk of cows when feeding them feed grown using intensive technologies]. *Izvestiya Gorskogo gosudarstvennogo agrarnogo universiteta*, 1, 59–62.
- [18] Vologzhanina, A. V., Berezkina, G. Yu., & Vorobeva, S. L. (2018). Kachestvo i tekhnologicheskie svoistva moloka pri ispolzovanii v kormlenii prirodnykh kormovykh dobavok [Quality and technological properties of milk when used in feeding natural feed additives]. *Uchenye zapiski Kazanskoi gosudarstvennoi akademii veterinarnoi meditsiny im. N.E. Bauman*, 234(2), 58–62.
- [19] Zoteev, V. S., Simonov, G. A., & Pisarev, E. I. (2016). Effektivnost ispolzovaniya netraditsionnykh istochnikov proteina v kombikormakh dlya laktiruyushchikh korov [Efficiency of using non-traditional sources of protein in compound feed for lactating cows]. *Izvestiya Samarskoi gosudarstvennoi sel'skokhozyaistvennoi akademii*, 2, 71–74.