International Journal of Design & Nature and Ecodynamics
Vol. 18, No. 3, June, 2023, pp. 727-733
Journal homepage: http://iieta.org/journals/ijdne

Enhancing Milk Productivity in Dairy Cows Through the Optimized Utilization of Oilseed Byproducts

Zhibek Nokusheva[1], Elmira Kantarbayeva[2*], Zhanetta Issayeva[3], Assel Tokusheva[4], Nurgul Meldebekova[5]

[1] Scientific Innovative Complex, North Kazakhstan Scientific Research Institute of Agriculture, Beskol 150000, Republic of Kazakhstan
[2] Department of Agronomy and Forestry, M. Kozybayev North Kazakhstan University, Petropavlovsk 150000, Republic of Kazakhstan
[3] Faculty of Engineering and Technology, Innovative University of Eurasia, Pavlodar 140000, Republic of Kazakhstan
[4] Department of Biology, Ecology and Chemistry, A. Baitursynov Kostanay Regional University, Kostanay 110000, Republic of Kazakhstan
[5] Department of Pasture Resources Management, Kazakh Research Institute of Livestock and Fodder Production, Almaty 050043, Republic of Kazakhstan

Corresponding Author Email: elmirakantarbaeva@yahoo.com

https://doi.org/10.18280/ijdne.180326

Received: 16 February 2023
Accepted: 15 May 2023

Keywords:
diet, oil and fat industry, cow, stern, seeds, oilcake

ABSTRACT

This study aimed to substantiate the need for the optimized utilization of oilseed byproducts to enhance milk productivity in dairy cows. Diets were formulated for cows using the Cornell Net Carbohydrate and Protein System v6.1. The effectiveness of incorporating oilseed byproducts into cow diets on milk productivity was assessed, and the results are presented in this article. It was observed that the cows in the second and third experimental groups, which received 30% and 25% oilseed byproducts in their diets, respectively, demonstrated increased milk yields compared to the control group. The diet for the second group consisted of 70% of the main diet and 30% oilseed byproducts (sunflower, rapeseed), while the diet for the third group comprised 75% of the main diet and 25% oilseed byproducts. The findings of this study indicate the feasibility and rationality of utilizing oilseed byproducts to enhance milk productivity in dairy cows.

1. INTRODUCTION

In the oil and fat industry, the processing of seeds generates significant amounts of byproducts, including cake, meal, and seed waste. During the seed cleaning process, up to 15% of waste is produced, and a substantial proportion of crushed seeds are obtained, which are of higher quality compared to conventional seeds [1]. Sunflower husks, for instance, are utilized as raw materials for furfural production and as feed additives for farm animals [1]. Cake and meal, derived from oilseed processing in oil extraction production, possess substantial amounts of vitamins, minerals, and beneficial components, making them valuable feed additives for farm animals, particularly cows [2]. Due to their high content of amino acids and protein, these byproducts can be combined with conventional feeds to produce high-protein concentrates for all types of farm animals.

The Republic of Kazakhstan is seeking to reduce its dependence on imported materials and components for milk production and livestock development. Experts suggest that increasing productivity or improving herd quality are potential solutions [3]. One approach to enhance milk productivity in cows is the utilization of oilseed byproducts from local industries. Oil crops, such as sunflower, flax, rapeseed, soybeans, mustard, peanuts, and hemp, are commonly processed for their seeds, which contain 30-35% crude protein and up to 10% fats [2]. For example, soybean, a protein-oil crop, is utilized in the food, confectionery, and baking industries, while its meal and cake are employed as animal feed [4]. Similarly, rapeseed is a source of edible oil and feed protein, with its meal and cake surpassing soybean products in terms of phosphorus, copper, calcium, magnesium, and manganese content [5].

Milk productivity in cows has been found to vary significantly under the same feeding and management conditions, as well as milking and preparation processes [6]. This variation is attributed to different selection and breeding of particular generations. Ecogenesis also affects cow productivity throughout lactation. In the Republic of Kazakhstan, processed milk production has not met the demand, with a shortfall in raw materials potentially linked to inadequate cow diets [7]. Since 2009, there has been an effort to distribute high-yielding dairy cattle breeds across different climatic zones in the country, with specific caution against mating Holstein purebred cattle with Kazakh Black-and-White cattle due to adverse effects on milk production [8]. These studies on milk productivity, the current state of cattle breeding, and the need to apply various methods for improving cow feeding and management conditions underscore the relevance of this investigation. Consequently, this study aimed to substantiate the need for the rational use of oilseed waste to increase the milk productivity of cows.

2. MATERIALS AND METHODS

Experimental studies were carried out on the livestock of the dairy herd of the red steppe breed based on the North Kazakhstan Scientific Research Institute of Agriculture, the YAKOR-SK dairy complex of the Kyzylzhar district, North Kazakhstan region. 30 cows were selected to form three groups: group 1 (control) received the main diet – silage, grain mixture, hay, and straw; 2nd group, experimental, the diet was 70% of the main diet and 30% of oilseed waste (sunflower, rapeseed); The 3rd group, experimental, the diet was 75% of the main diet and 25% of oilseed waste (sunflower, flax). The basis for dividing the groups was to assess the impact of including oilseed waste in the diets of dairy cows on milk production and quality. By comparing the performance of the experimental groups to the control group, the study could determine the potential benefits of incorporating oilseed waste into the diet. The selection of 30 cows was based on the principle of sample size determination in scientific research. A sample size of 30 is often considered sufficient for experimental studies and can provide statistically meaningful results. The ratios of 70-30 and 75-25 were determined based on previous research and experience with incorporating oilseed waste into the diets of dairy cows. These ratios have been considered suitable for achieving a balance between providing the necessary nutrients for the cows while also incorporating a significant portion of oilseed waste into the diet. The rations were taken in the form of group feeding and a generally mixed ration twice a day – in the morning and in the evening, and the animals had free access to water. The cows were eaten three times a day. Milk samples were analyzed for fat, protein, solids, and solids using milkoscan (EKOMILK, MilkanaKam 98-2A, Foss Electric, Denmark). Feeding rations were matched for energy content, protein, starch, fiber, vitamins, and minerals, which were formulated according to the needs of the livestock. The diets were developed using Cornell Net Carbohydrate and Protein System (CNCPS) v 6.1 [9, 10] to meet the needs of the animals. The CNCPS system predicts the needs of cattle and the supply of nutrients for specific situations.

CNCPS version 6, is a revision and update of previous versions with the following goals: improve model organization and user interface to increase speed and accuracy in formulating diets for dairy cattle herds, expand carbohydrates to include sugars, soluble fibers, organic and volatile fatty acids, integrate a fat model to account for rumen lipolization and biohydrogenation, absorption of fatty acids in the small intestine, and update computational submodels with new information [9, 10]. The quality indicators of the feeds and additives that were used met the requirements of GOST 32040-2012 “Feed, compound feed, compound feed raw materials. Method for determination of crude protein, crude fiber, crude fat, and moisture using near-infrared spectroscopy” [11]. When preparing samples for research, it was necessary to strictly follow the procedure for grinding samples, since the particle size significantly affects the measurement result. The crushed analyzed sample is transferred into a tightly closed container and, after it is cooled to room temperature, is used to take the spectrum. If necessary, the analyzed sample is stored in a sealed glass or plastic container in a dry, dark place for the recommended shelf life of the test product.

According to the Agency for Strategic planning and reforms of the Republic of Kazakhstan Bureau of National statistics [12], an analysis was made of the production of all types of milk during 2019-2021; oilseed yields – from 2015-2021; harvested areas for the production of rapeseed, flax in the Republic of Kazakhstan – from 2016-2021; updated sown area of oilseeds, in particular, sunflower – 2015-2021; the gross harvest of oilseeds, in particular, sunflower – from 2015-2021.

3. RESULTS

Before the start of the experiment, it was necessary to choose the type of diet. Based on the theoretical and analytical study, the following conclusions were drawn. The main ways of feeding different types of feed are the general, mixed diet and feeding each type of feed separately. In a mixed diet, all types of food are given together, taking into account the diet by physiological norms for nutritional value and the amount of dry matter at the same time. Selective feeding of different types of food separately will give preference to the strongest animals, which will significantly reduce the efficiency of feeding. A logical technological approach that complements this scheme is feeding with a complete mixture. This makes it possible to largely equalize the feed intake of each animal in the group. Another preferred option is a feed mixture, but only partially mixed with certain types of feed, together with the feeding of certain types of feed. Each of these feeding technologies has its own advantages, problems, and limitations.

Feeding with general compound feed is considered effective, although it requires certain additional costs, organizational efforts, and highly qualified specialists. Problems of separate feeding of different types of food can be caused by competition between animals for food and often selective consumption of food. As a consequence, the actual diet that the animals consume is not balanced. These characteristics affect the behavioral responses of animals to feed distribution, feed intake, and the amount of feed consumed. In connection with the development of the oilseed industry, there is a need to develop waste-free production in relation to industrial waste. To assess the scale of production, it was necessary to conduct a logical analysis of the official statistical data of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan Bureau of National Statistics [12]. It was established that in recent years the area under oilseeds has increased significantly, including flax, rapeseed, and sunflower. The upward trend continued every year. So, since 2015, the area under crops has increased by 54%, and since 2020 it has grown by another 7%. In particular, the area under sunflower crops increased by 29%. Despite the fact that during 2017-2020 the area decreased by almost 140 thousand hectares, or more than 10% (Figure 1).

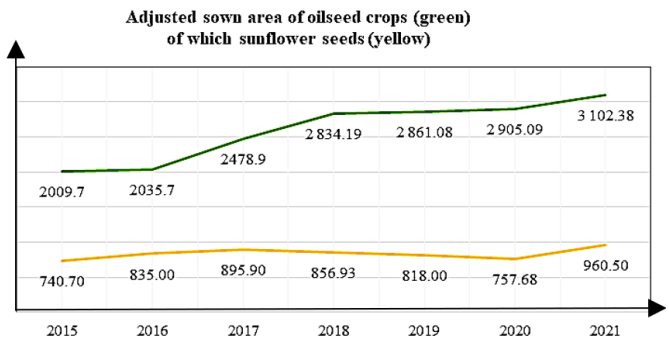

Figure 1. Adjusted sown area of oilseed crops

As for the collection of oilseeds, despite the increase in the area of crops, the harvest has been decreasing in recent years. Since 2018, the harvest has decreased by 10%. Such results are likely to be related to global climate change. This issue requires further research. In general, over the period 2015-2021, the collection of oilseeds increased by 57%, in particular, this is due to an increase in sown areas (Figure 2).

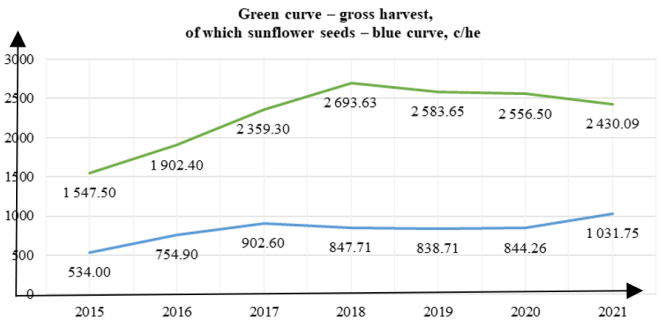

Figure 2. Gross harvest of oilseeds

Peak demand for rapeseed was observed in the period 2018/2019. After that, a reduction in sown areas and, accordingly, the production of this crop was recorded (Figure 3).

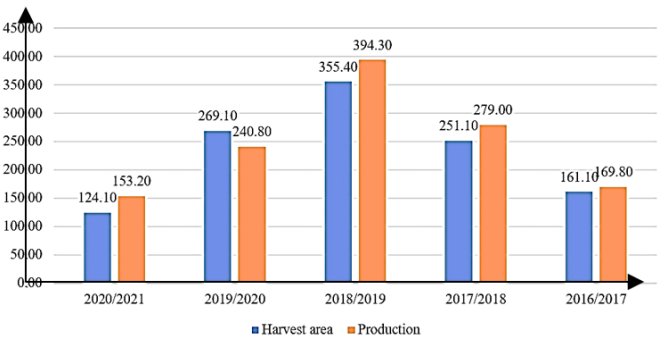

Figure 3. Harvested area/rapeseed production

As of 2020-2021, they noted a decrease in production volumes by 57.2% and twice about 2019/2020 and 2018/2019, respectively. Demand to expand flax acreage remains. In all likelihood, this was due to its high purchase price. Also, today flax is one of the high-margin crops in Kazakhstan. Although, despite the increase in area, production volumes have not increased significantly over the past three years (Figure 4).

Therefore, compared to 2018/2019, they noted an increase in production volumes by 7.9% and 13.4%, respectively, in 2019/2020 and 2020/2021. So, it can be saw a trend towards a general increase in the production of oilseeds in subsequent years and, accordingly, the need for the rational use of their waste. The next stage of research was an analytical and logical analysis of the possibility of using oilseed waste in the diet of a dairy herd of cows. Cake and oilseed meal is an excellent protein feed, in particular for cows. It is known that feeding rapeseed cake to cattle increases the content of protein and volatile fatty acids in the scar tissue, increases the number of ciliates, and reduces the level of ammonia. Flax seeds are rich in polyunsaturated fatty acids, which have a positive effect on the basic life processes of the body. Sunflower cake is a balanced and nutritious raw material for the production of animal feed and one of the most valuable types of feed for farm animals. It contains 26% carbohydrates, 40% protein, 7% fat and 6% fiber [13]. Scales are also rich in non-starchy polysaccharides such as cellulose, lignin, and hemicellulose. When used in the production of a special substrate, cellulolytic enzymes can be obtained. These enzyme preparations as biological catalysts can be used in animal husbandry, in particular, due to their use, the digestibility of feed for farm animals increases [14]. Therefore, the introduction of oil industry waste into the diet of dairy cows has a scientific justification and requires further experimental confirmation. According to the results of studies, the introduction of oilseed waste into the diet of dairy cows affected milk productivity (Table 1), and the quality and technological properties of milk.

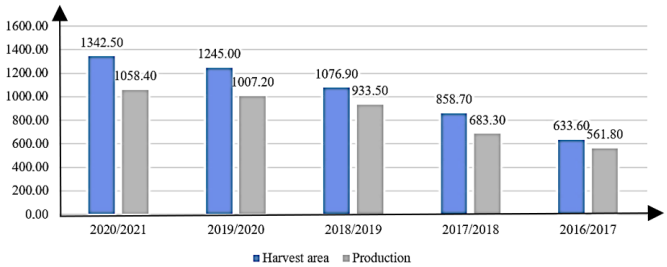

Figure 4. Harvested area/flax production

Table 1. Milk productivity of cows

Index	Group		
	1	2	3
Milk per lactation, kg	7759.7	8874.45	8372.43
Duration of lactation, days	346	335	344
Average daily milk yield per lactation, kg	22.427	26.49	24.327
Milk yield for the first 100 days of lactation, kg	3041.55	3729.69	3551.67
Milk yield for 305 days of lactation, kg	6840	8079.45	7419.74
Average daily milk yield, kg	22.572	27.171	25.875
Average daily milk yield during milking, kg	30.42	37.296	35.514
Live weight, kg	554.4	550.8	553.5

Cows fed sunflower seeds and rapeseed in the diet (the second experimental group) exceeded other groups in terms of milk productivity. For the first 100 days of lactation, it is 4.7% and 18.4% more than in the cows of the third experimental and control groups, respectively. The chemical composition of milk from the tested groups of animals is given in Table 2.

According to the research results, the content of dry matter in milk was 12.64-13.21%. The content of dry skimmed milk residue in the milk of the studied animals was at the level of 8.98-9.34%. In the milk of cows of the 2nd experimental group, a higher content of dry fat-free milk residue was found in comparison with the control group (1) by 0.36% and in comparison, with the milk of cows of the third experimental group by 0.15%. As for the calorie content, it is in the range of 69.86-72.15%. The fat content in the milk of cows of the experimental groups was 4.23-4.32%, which is 0.18-0.27% higher than the control group. The use of oilseeds in feeding cows had a positive effect on the mass fraction of protein in milk. The values of this indicator for cows of the second and third experimental groups were 3.33% and 3.30%, respectively, which is higher by 0.15% and 0.12%, respectively, compared with the control group. According to the results of the analysis of the obtained physicochemical parameters of cows' milk, it was found that in the studies the

milk from cows of the second and third groups was better. Therefore, it contained more solids and fat, which in turn affected the calorie content of the product. Analyzing the data of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan Bureau of National statistics [12] on the production of all types of milk in different regions of the Republic of Kazakhstan, over the past three years there has been a tendency to increase milk production. So, from 5865.1 thousand tons in 2019 to 6247.2 thousand tons in 2021 (Figure 5).

Table 2. Physical and chemical indicators of milk

Index	Group		
	1	2	3
Dry matter, %	12.64	13.21	13.17
DSMR[1], %	8.98	9.34	9.19
Fat, %	4.05	4.23	4.32
total protein, %	3.18	3.33	3.30
including casein, %	2.58	2.6	2.61
Lactose, %	4.67	4.69	4.69
Ash, %	0.87	0.88	0.87
Density, %	29.5	29.3	29.4
Acidity %	16.3	16.4	16.4
Calorie content, kcal	69.86	71.85	72.15

Note: [1]– dry skimmed milk residue

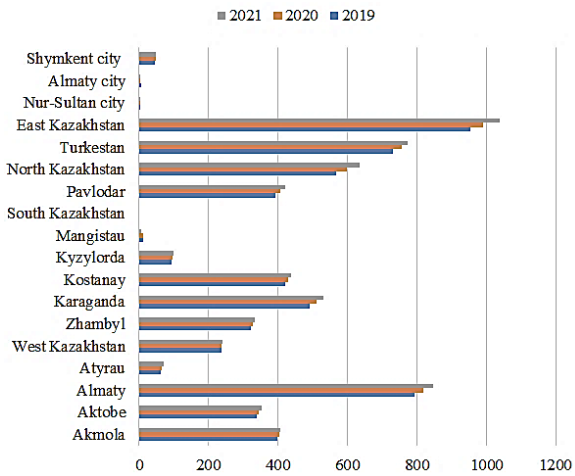

Figure 5. Production of milk of all kinds

In view of the tendency to increase milk production, it would be rational to use the waste from the oilseed industry to improve its quality. According to the results of the research, it was found that the addition of a feed additive from oilseed waste, in particular sunflower cake and meal, rapeseed, and flax for feeding cows, has a positive effect and increases milk productivity.

The results of this study provide valuable insights into the potential benefits of using oilseed waste in the diet of dairy cows to increase milk productivity. However, before promoting this study to the livestock of large different populations, it is important to consider a few factors. Firstly, it is essential to ensure that the specific type of oilseed waste being used is safe and suitable for the livestock population in question. Some oilseed waste may contain toxins or anti-nutritional factors that could be harmful to the animals. Secondly, the optimal ratio of oilseed waste in the diet may vary depending on the specific nutritional requirements of the livestock population being studied. Different breeds of cows, for example, may have different nutrient requirements and may respond differently to changes in their diet. Therefore, while the results of this study are promising, further research would be necessary to determine the optimal use of oilseed waste in the diet of different livestock populations. This research would need to consider the specific nutritional requirements and other factors that may affect the health and productivity of the animals.

4. DISCUSSION

Feeding with a general compound feed is considered effective but requires additional costs, organizational efforts, and highly qualified specialists. The selective feeding of different types of food can cause competition between animals and selective consumption of food, leading to an unbalanced diet. The study found that cows fed sunflower seeds and rapeseed in the diet had higher milk productivity than other groups. The study's findings reveal that oilseed waste, such as sunflower cake and meal, rapeseed, and flax, can be used in the diet of dairy cows to improve milk productivity. However, the study's results are limited to the specific conditions and livestock of the dairy herd of the red steppe breed in North Kazakhstan. It may not necessarily apply to other livestock populations or regions with different environmental conditions, diets, or breeding practices. Therefore, further research and experimentation are necessary to determine the optimal conditions for the use of oilseed waste to increase milk productivity in different livestock populations.

There are more than 608 million farms in the world, which produce approximately 80% of the world's food in value terms [15]. The main cultivated crops are cereals, oilseeds, legumes, fiber crops, sugar crops, fodder crops, medicinal crops, roots and tubers, vegetable or horticultural crops, etc. [16, 17]. Soybeans account for more than half of world production and more than a quarter of the protein used for food and animal feed [18-20]. Feed for efficient and rational feeding of farm animals should contain a sufficient amount of nutrients: macronutrients, minerals, and vitamins [21-23]. Contaminated samples must be processed for detoxification. Since high doses of pollution, in particular, aflatoxins can be the main cause of liver diseases such as cirrhosis, cancer, and death of animals [24-26]. Meagher et al. [27-29] prove that the productivity of cows' milk depends on many factors, in particular, feeding regimes, the way cows are kept, diets, behavior, and stress. During the experiment [29], the diet of cows was 70% regular untreated hay and 30% concentrated supplements, including improved grass hay, cleaned straw silage, and plant waste. Automatic feeding systems provide more frequent delivery of fresh feed to cows compared to conventional feeding systems [28, 30]. Weiss [31] studied the effect of feed diets consisting of vegetable and grain components with and without additional lysine and methionine to increase the milk production of cows. Studies have designed diets to contain the same concentration of net energy for lactation and metabolizable protein.

When planning to increase milk production, it is also important to pay attention to the immune status and health of the cows. Neutrophils are the most prominent line of cellular defense against invading microorganisms [32], sulfate, hydroxyl chloride, or organic chelate can affect the interaction between metals and other components present in the gut of cows. Micronutrient sources have been shown to affect the digestibility of the entire tract, and indicate that this may also

affect milk performance [33, 34]. The analysis of scientific publications confirms the positive impact of the use of cake and oilseed meals on the productivity of cattle. De Vries and Marcondes [35] paid attention to the influence of life expectancy and productivity of cows in different countries, in particular in Denmark, the Netherlands, and North America, risk factors for culling in a dairy herd, in particular, due to a decrease in milk productivity. The researchers conclude that culling is avoided in the dairy herd, in case of timely fertilization, prevention of mastitis, injuries, and other diseases, which ensures good animal health, in particular, strong limbs and a functional udder. It is accepted that the key to the high productivity of a dairy herd is the following frequency of use: the first insemination leads to pregnancy; pregnancy diagnosis confirms pregnancy; dead wood completes lactation and the hotel begins a new lactation.

Many studies are concerned with improving the nutrition of dairy cows to improve their productivity or milk quality. Hubanova et al. [36] established a positive effect of the organic form of mixed Cu, Zn, and Mn complexes on the milk productivity of highly productive Holstein cows. It was proved that the highest milk productivity during the milking period had cows that consumed mixtures-ligand complexes of Cu, Zn, and Mn in the amount of 100% of the metal concentration as part of the feed. Also, in terms of the level of protein in milk, the experimental cows had an advantage of 3.4%. In this experiment, the experimental groups of cows also had an increased content of total protein compared to the control. This confirms the need to improve the diets of dairy cows through the addition of oil industry waste. Hutjens [37] establishes the requirements for the ratio of fat and protein in animals of different breeds. He notes that the content of fat and protein in milk depends primarily on the characteristics of feeding: the ability to provide the diet of cows with certain feed components or the proportions of certain feeds. The scientist identifies the following main approaches to controlling the level of protein in milk: the need to assess the level of amino acids in feed and especially the possibility for their synthesis; assessment of undegraded protein in the felling and the possibility of using body reserves to ensure energy balance; bringing the level of lysine and methionine to normal 6.2-6.6% and 2-2.2%, respectively, in a ratio of 3:1 [38].

Given this, authors see the need to continue research in the direction of determining the level of synthesis of amino acids from feed and the impact of using oilseed waste in diets on the energy balance of the body of cows. Unfortunately, due to the oversaturation of crop rotations with sunflowers, there is a gradual depletion and drying of soils, and deterioration of their physical and chemical properties. This factor is confirmed by the statistics described above when the area under crops increased and the collection of seeds decreased. That is why it is necessary to improve the process of growing oilseeds, to apply new methods of cultivation, which significantly increased the yield, and did not reduce it, as has been happening in recent years. It is necessary to achieve the planned seed collection not by increasing the area, but by a significant increase in productivity. This will make it possible to obtain better crops for further processing and production of feed for farm animals, in particular for the preparation of feed to increase milk productivity. It is also necessary to ensure the saturation of the domestic market with high-protein feeds, such as meals or oilcake because they play an important role in animal husbandry. With a reduction in the processing of oilseeds, a shortage and dependence on imported feed suppliers will form [39-41].

5. CONCLUSIONS

Including waste from processing rapeseed, sunflower, and flax seeds in the diet of cows has been found to enhance milk production and quality. Flax seeds contribute to a higher fat content in milk, while rapeseed increases fat and protein levels. Further research is needed to explore the impact of oilseed meals and cake on the fatty acid composition of milk. The use of oilseed waste in the diets of dairy cows has been shown to increase the content of solids, fat, and protein, as well as calorie content, compared to a control group. Milk productivity increased by 4.7% and 18.4% throughout the lactation period for the second and third experimental groups, respectively, while the average daily milk yield increased by 20% and 14%. In recent years, milk production and production capacities have increased in Kazakhstan, with a 57% increase in oilseed collection since 2015. The rational use of oilseed waste is important due to the growing production of oilseeds. The study's findings indicate the feasibility of using oilseed waste to boost milk production in cows. Future research could focus on developing feeding schemes that use the biologically active substances found in oilseeds to feed dairy herds adequately.

REFERENCES

[1] Serdyuk, V.A., Maltseva, T.A., Tupolskih, T.I., Lomakina, S.A. (2020). Tendencies of Resource-Saving Technologies in the Field of Separation of Oil Raw Materials. In: State and Prospects of Development of the Agro-industrial Complex, Rostov-on-Don: DGTU-Print, pp. 602-605.

[2] Shcherbakov, V.G., Lobanov, V.G. (2016). Biochemistry and commodity science of oilseed raw materials. St. Petersburg: Lan.

[3] Trofimov, A. (2018). Dairy transformation. Kazakhstani experience in the development of dairy production. https://www.agroinvestor.ru/technologies/article/29545-molochnoe-preobrazovanie/.

[4] Mohylians' ka, N.O. (2014). Current state and prospects of oilseeds processing. Zernovi produkty i kombikormy, 1(53): 22-25.

[5] Brahinets, M.V., Bohomolov, O.V., Bohomolov, O.O. (2020). Use of rapeseed for feed in animal husbandry and its cleaning. In: Innovative, Technical and Technological Support of the Livestock Industry, Kharkiv: KhNTUA, pp. 142-143.

[6] Ponomareva, Y.A., Tatarkina, N.I. (2019). Milk productivity of Holstein cows of various origins. Bulletin of the Kurgan State Agricultural Academy, 1(29): 43-45.

[7] Production of meat and dairy products for January-April 2021-2022. (2022). https://www.gov.kz/memleket/entities/moa/documents/details/304481?directionId=10021&lang=ru.

[8] Baymukanov, D. (2015). Holsteinization in Kazakh: the experience of breeding a factory type of dairy cattle. https://www.agroinvestor.ru/regions/article/22582-golshtinizatsiya-po-kazakhski/.

[9] Tylutki, T.P., Fox, D.G., Durbal, V.M., Tedeschi, L.O., Russell, J.B., Van Amburgh, M.E., Overton, T.R., Chase,

L.E., Pell, A.N. (2008). Cornell net carbohydrate and protein system: A model for precision feeding of dairy cattle. Animal Feed Science and Technology, 143: 174-202. https://doi.org/10.1016/j.anifeedsci.2007.05.010

[10] Van Amburgh, M., Chase, L., Overton, T., Ross, D., Recktenwald, E., Higgs, R., Tylutki, T. (2010). Updates to the cornell net carbohydrate and protein system v6. 1 and implications for ration formulation. In: Cornell Nutrition Conference, Ithaca: Cornell University, pp. 144-159.

[11] GOST 32040-2012. (2012). Feed, compound feed, compound feed raw materials. Method for determination of crude protein, crude fiber, crude fat, and moisture using near-infrared spectroscopy. https://files.stroyinf.ru/Data/551/55122.pdf.

[12] Agency for Strategic Planning and Reforms of the Republic of Kazakhstan Bureau of National Statistics. (2022). https://stat.gov.kz/official/industry/14/statistic/7.

[13] Nedelkov, K., Todorov, N., Simeonov, M., Girginov, D., Ganchev, G. (2017). In situ rumen degradability and intestinal digestibility of two different types of rapeseed meal. Bulgarian Journal of Agricultural Science, 23(3): 462-466.

[14] Karimzoda, M.T., Rajabov, F.M. (2021). The efficiency of use of waste from the processing of various oilseeds in dairy cattle breeding in Tajikistan. In: Innovative Technologies in Production and Processing of Agricultural Products, Makhachkala: Dagestan State Agrarian University named after M.M. Dzhambulatova, pp. 42-49.

[15] Lowder, S.K., Sánchez, M.V., Bertini, R. (2021). Which farms feed the world and has farmland become more concentrated? World Development, 142: 105455. https://doi.org/10.1016/j.worlddev.2021.105455

[16] Naz, S., Fatima, Z., Iqbal, P., Khan, A., Zakir, I., Noreen, S., Ahmad, S. (2019). Agronomic crops: types and uses. Agronomic Crops: 1: 1-18. https://doi.org/10.1007/978-981-32-9151-5_1

[17] Nagovska, V., Hachak, Y., Gutyj, B., Bilyk, O., Slyvka, N. (2018). Influence of wheat bran on quality indicators of a sour milk beverage. Eastern-European Journal of Enterprise Technologies, 4(11-94): 28-34.

[18] Wang, S., Liu, S., Wang, J., Yokosho, K., Zhou, B., Yu, Y.C., Tian, Z. (2020). Simultaneous changes in seed size, oil content, and protein content are driven by a selection of SWEET homologs during soybean domestication. National Science Review, 7(11): 1776-1786. https://doi.org/10.1093/nsr/nwaa110

[19] Shukesheva, S.E., Uzakov, Y.M., Chernukha, I.M., Nabiyeva, Z.S., Kozybayev, A. (2018). On the role of controlling systems in the quality of food products. Journal of Advanced Research in Dynamical and Control Systems, 10(13 Special Issue): 642-648.

[20] Myrkhalykov, Z., Konarbayeva, Z., Saparbekova, A., Mamaeva, L., Yussubaeva, A., Auezov, M. (2013). Selection of starter cultures for producing milk products in media containing grain additives. Biomedical and Pharmacology Journal, 6(2): 169-176. https://doi.org/10.13005/bpj/400

[21] Porto, R.G., Cruz-Neto, O., Tabarelli, M., Viana, B.F., Peres, C.A., Lopes, A.V. (2021). Pollinator-dependent crops in Brazil yield nearly half of the nutrients for humans and livestock feed. Global Food Security, 31: 100587. https://doi.org/10.1016/j.gfs.2021.100587

[22] Kaimbayeva, L., Kenenbay, S., Zhantleuov, D., Tayeva, A., Akhmetova, N., Medeubayeva, Z. (2020). Evaluation of autolysis induced histologic alterations in skeletal muscle tissue of non-traditional meat animals. Food Science and Technology (Brazil), 40(3): 736-740. https://doi.org/10.1590/fst.18319

[23] Kaimbayeva, L., Kenenbay, S., Dikhanbaeva, F., Tnymbaeva, B., Kazihanova, S. (2021). Histological studies of the muscle tissue of the bactrian camel meat in the process of autolysis. Food Science and Technology (Brazil), 41(2): 371-375. https://doi.org/10.1590/fst.02520

[24] Nazir, A., Kalim, I., Imran, M., Bilal, M.A., Zahra, N., Ahmad, A., Ehtisham-ul-Haque, S. (2021). Incidences and bio-detoxification of aflatoxins in rice and cattle feed crops under different agro-ecological zones. Polish Journal of Environmental Studies, 30(2): 1949-1954. http://dx.doi.org/10.15244/pjoes/121050

[25] Gryshchenko, V.A., Musiychuk, V.V., Chernyshenko, V.O., Gornytska, O.V., Platonova, T.M. (2019). Evaluation of biochemical indicators in blood plasma of rats with tetracycline-induced hepatosis and their correction by milk phospholipids. Ukrainian Biochemical Journal, 91(1): 92-99.

[26] Gryshchenko, V.A., Chernyshenko, T.M., Gornitska, O.V., Platonova, T.M. (2016). Evaluation of the functional state of liver and the efficiency of therapy for enteropathy of calves. Fiziolohichnyi zhurnal (Kiev, Ukraine: 1994), 62(6): 102-109.

[27] Meagher, R.K., Beaver, A., Weary, D.M., von Keyserlingk, M.A. (2019). Invited review: A systematic review of the effects of prolonged cow-calf contact on behavior, welfare, and productivity. Journal of Dairy Science, 102(7): 5765-5783. https://doi.org/10.3168/jds.2018-16021

[28] Mattachini, G., Pompe, J., Finzi, A., Tullo, E., Riva, E., Provolo, G. (2019). Effects of feeding frequency on the lying behavior of dairy cows in loose housing with automatic feeding and milking system. Animals, 9(4): 121. https://doi.org/10.3390/ani9040121

[29] Mekuriaw, S., Tsunekawa, A., Ichinohe, T., Tegegne, F., Haregeweyn, N., Kobayashi, N., Fievez, V. (2020). Effect of feeding improved grass hays and Eragrostis tef straw silage on milk yield, nitrogen utilization, and methane emission of lactating fog era dairy cows in Ethiopia. Animals, 10(6): 1021. https://doi.org/10.3390/ani10061021

[30] Khastayeva, A.Z., Zhamurova, V.S., Mamayeva, L.A., Kozhabergenov, A.T., Karimov, N.Z., Muratbekova, K.M. (2021). Qualitative indicators of milk of Simmental and Holstein cows in different seasons of lactation. Veterinary World, 14(4): 956-963. https://doi.org/10.14202/vetworld.2021.956-963

[31] Weiss, W.P. (2019). Effects of feeding diets composed of corn silage and a corn milling product with and without supplemental lysine and methionine to dairy cows. Journal of Dairy Science, 102(3): 2075-2084. https://doi.org/10.3390/ani10061021

[32] Alhussien, M.N., Dang, A.K. (2019). Potential roles of neutrophils in maintaining the health and productivity of dairy cows during various physiological and physiopathological conditions: A review. Immunologic Research, 67(1): 21-38. https://doi.org/10.1007/s12026-019-9064-5

[33] Daniel, J.B., Kvidera, S.K., Martin-Tereso, J. (2020). Total-tract digestibility and milk productivity of dairy cows as affected by trace mineral sources. Journal of Dairy Science, 103(10): 9081-9089. https://doi.org/10.3168/jds.2020-18754

[34] Bilyk, O., Slyvka, N., Gutyj, B., Dronyk, H., Sukhorska, O. (2017). Substantiation of the method of protein extraction from sheep and cow whey for producing the cheese «urda». Eastern-European Journal of Enterprise Technologies, 3(11-87): 18-22.

[35] De Vries, A., Marcondes, M. (2020). Review: Overview of factors affecting the productive lifespan of dairy cows. Animal, 14(S1): S155-S164. https://doi.org/10.1017/S1751731119003264

[36] Hubanova, N., Horchanok, A., Bomko, V., Kuzmenko, O., Novitskiy, R., Sobolev, O., Tkachenko, M., Prisjazhnjuk, N. (2019). Influence of chelations on dairy productivity of cows in different periods of the manufacturing cycle. Ukrainian Journal of Ecology, 9(1): 231-234. http://rep.btsau.edu.ua/handle/BNAU/2077.

[37] Hutjens, M.F. (2005). Dairy Efficiency and Dry Matter Intake. In: University of Illinois Proceedings of the 7th Western Dairy Management Conference, Reno, pp. 71-76.

[38] Dikhanbayeva, F., Zhaxybayeva, E., Dimitrov, Z., Baiysbayeva, M., Yessirkep, G., Bansal, N. (2021). Studying the effect of the developed technology on the chemical composition of yogurt made from camel milk. Eastern-European Journal of Enterprise Technologies, 3(11-111): 36-48. https://doi.org/10.15587/1729-4061.2021.235831

[39] Ibragimov, Y. (2022). Kazakhstan needs to determine its positions in the oil and fat industry on the international market. https://www.apk-inform.com/ru/exclusive/opinion/1525003.

[40] Mylostyvyi, R., Sejian, V., Izhboldina, O., Kalinichenko, O., Karlova, L., Lesnovskay, O., Begma, N., Marenkov, O., Lykhach, V., Midyk, S., Cherniy, N., Gutyj, B., Hoffmann, G. (2021). Changes in the spectrum of free fatty acids in blood serum of dairy cows during a prolonged summer heat wave. Animals, 11(12): 3391.

[41] Mylostyvyi, R., Lesnovskay, O., Karlova, L., Khmeleva, O., Kalinichenko, O., Orishchuk, O., Tsap, S., Begma, N., Cherniy, N., Gutyj, B., Izhboldina, O. (2021). Brown Swiss cows are more heat resistant than Holstein cows under hot summer conditions of the continental climate of Ukraine. Journal of Animal Behaviour and Biometeorology, 9(4): 2134.