

THE IMPACT OF NON-TRADITIONAL OILSEED WASTE ON DAIRY PRODUCTIVITY OF COWS

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This article presents the results of research aimed at studying the effectiveness of a new formula for compound feed for lactating cows that includes non-traditional oilseed waste. The aim of the study was to evaluate the impact of the new feed on milk production and milk quality. The research was conducted at the Yntymak farm in a scientific and farming trial, with a control group and three experimental groups of animals matched for age, body weight, and physiological condition. Cows in the experimental groups received a diet containing the developed feed, while animals in the control group were kept on the farm's standard diet. The studies revealed that the use of the newly developed feed increased milk production. The highest average daily milk yield was observed in cows in the second experimental group, reaching 23.2 kg, 16% higher than in the control group. Improvements in milk quality were also observed, including an increase in the content of complete protein, a key indicator of its nutritional and biological value. The highest protein content was recorded in the milk of cows in the second experimental group. Overall, the experimental group animals outperformed the control group in key physicochemical milk parameters. The use of compound feed with the inclusion of non-traditional raw materials allows for a reduction in the proportion of grain components, a reduction in the cost of feed, an increase in its biological value and an environmental efficiency of production.

Keywords: feed, formulation, diet, productivity, waste from oilseeds.

ДӘСТҮРЛІ ЕМЕС МАЙЛЫ ДАҚЫЛДАРДЫҢ ҚАЛДЫҚТАРЫНЫҢ САУЫНДЫ СИЫРЛАРДЫҢ СҮТ ӨНІМДІЛІГІНЕ ӘСЕРІ

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Мақалада майлы дақылдардың дәстүрлі емес қалдықтарын құра жем құрамына енгізу арқылы сауынды сиырларға арналған жаңа құрама жем рецепіні қолданудың тиімділігін зерттеуге бағытталған зерттеу нәтижелері ұсынылған. Зерттеудің мақсаты жаңа құрама жемнің сүт өнімділігі деңгейіне, сондай-ақ сүттің сапалық құрамына әсерін бағалау болды. Зерттеулер "Ынтымақ" ШҚ базасында жасына, тірі салмағына және физиологиялық жағдайына ұқсас жануарлардан үш тәжірибелік тобын қалыптастыра отырып оларға ғылыми-шаруашылық тәжірибе жүргізілді. Тәжірибелі топтардағы сиырлар азығына жаңа рецеппен әзірленген құрама жем берілді, ал бақылау тобындағы сиырларға шаруашылықтың негізгі рационындағы жем ұсталды. Жүргізілген зерттеулер нәтижесінде әзірленген құрама жемді қолдану сүт өнімділігінің артуына ықпал еткені анықталды. Ең үлкен орташа тәуліктік сүт екінші тәжірибелік топтағы сиырларда байқалды ол 23,2 кг құрады, бұл бақылау нұсқасымен салыстырғанда 16% - га жоғары. Сонымен бірге сүттің сапалық көрсеткіштерінің жақсаруы, оның ішінде оның тағамдық және биологиялық құндылығының маңызды көрсеткіштерінің бірі болып табылатын толыққанды ақуыздың құрамының арқаны анықталды. Ақуыздың мөлшері екінші тәжірибелік топтағы сиырлардың сүтінде жоғары екені дәлелденді. Тәжірибелі топтардың жануарлары сүттің негізгі физика-химиялық көрсеткіштері бойынша бақылау жануарларынан басым болды. Дәстүрлі емес шикізатты қоса

отырып, құрама жемді қолдану астық компоненттерінің үлесін азайтуға, жемнің өзіндік құнын төмендетуге, олардың биологиялық сапасын арттыруға және өндірістің экологиялық тиімділігін қамтамасыз етуге мүмкіндік береді.

Негізгі сөздер: Жем, рецепт, тамақтануы, өнімділік, майлы дақылдардың қалдықтары.

ВЛИЯНИЕ НЕТРАДИЦИОННЫХ ОТХОДОВ МАСЛИЧНЫХ КУЛЬТУР НА МОЛОЧНУЮ ПРОДУКТИВНОСТЬ КОРОВ

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В статье представлены результаты исследований, направленных на изучение эффективности применения разработанного нового рецепта комбикорма для лактирующих коров с включением нетрадиционных отходов масличных культур. Целью исследования являлась оценка влияния нового комбикорма на уровень молочной продуктивности, а также на качественный состав молока. Исследования проводились на базе КХ «Бнтымак» в научно-хозяйственном опыте с формированием контрольной и трех опытных групп животных, идентичных по возрасту, живой массе и физиологическому состоянию. Коровы опытных групп получали рацион с использованием разработанного комбикорма, в то время как животные контрольной группы содержались на базовом рационе хозяйства. В результате проведенных исследований установлено, что применение нового разработанного комбикорма способствовало увеличению молочной продуктивности. Наибольший среднесуточный удой был отмечен у коров второй опытной группы и составил 23,2 кг, что на 16 % выше по сравнению с контрольным вариантом. Одновременно выявлено улучшение качественных показателей молока, в том числе повышение содержания полноценного белка, который является одним из важнейших показателей его пищевой и биологической ценности. Максимальные значения содержания белка зафиксированы в молоке коров второй опытной группы. Животные опытных групп в целом превосходили контрольных животных по основным физико-химическим показателям молока. Применение комбикорма с включением нетрадиционного сырья позволяет снизить долю зерновых компонентов, уменьшить себестоимость кормов, повысить их биологическую полноценность и обеспечить экологическую эффективность производства.

Ключевые слова: корма, рецептура, рацион, продуктивность, отходы масличных культур.

Introduction

The development of livestock farming is one of the main strategic economic objectives of Kazakhstan and continues to be the main source of employment, food and income for the rural population [1].

The needs of industrial-scale livestock farming for all species, groups, and ages of animals are met by feed milling, which is a distinct, established sector of industrialization. This sector fulfills a strategic task: providing agricultural producers with high-quality feed.

One of the main ways to improve production in agriculture is to rationalize operating costs, which leads to a reduction in the cost of finished products with high crop productivity.

A major role is given to the use of highly efficient resource-saving technologies that can reduce the environmental impact and are also less costly for agricultural enterprises. High-quality resource provision is one of the key components of the proportional and balanced development of grain processing and livestock farms as structural elements of the meat, dairy, and grain product industries. subcomplexes [2,3].

To ensure a stable ecological situation in the environment, it is necessary to have a more rational and economical use of material resources in the national economy, comprehensive processing of raw materials, low-waste, waste-free technology, the full involvement of local types of raw materials and materials in circulation, the recycling of secondary resources, and the maximum reduction in the use of

food raw materials and other agricultural products for technical purposes.

A pressing issue for agricultural production in our country is the ongoing and widespread adoption of new technologies, primarily aimed at ensuring food security. To achieve this, high productivity in livestock farming, including the production of maximum output that meets international standards, must be a key priority. However, one of the main factors hindering the achievement of these living standards is.

For the successful development of the feed industry, it is necessary to expand the feed supply and reduce the shortage of highly nutritious and affordable raw materials. Since feed accounts for approximately 70% of agricultural production costs, only improved feed quality and increased feed digestibility can enhance the competitiveness of domestic products [4, 5].

This use of grain is irrational, since the majority should be spent on food purposes.

At the same time, by-products and waste from various industries, as well as non-traditional types of raw materials, are underutilized [6,7].

In the context of developing market relations in the processing industries, raw materials play a special role, the real source of replenishment of which is the reduction of losses during harvesting, transportation, storage, and processing of products. When determining the level of technology, the goal is not only to increase the utilization of raw materials but also to ensure the production of useful products from waste, that is, to incorporate so-called secondary raw materials into production [8].

Secondary raw materials represent an easily renewable, cheap and accessible source of raw materials for new high-quality and nutritious feeds and, after appropriate processing, can acquire feed properties that are 1.5–3 times superior to good-quality feed grain [9,10].

Kazakhstan has significant potential to increase its share of the global oil and fat market. To this end, the government has taken steps to diversify crop production and shift away from monopolistic wheat cultivation toward expanding oilseed crops. Agricultural production is characterized by significant waste and byproducts. Growing grain and oilseed crops produces straw, baskets, and stalks.

One of the promising types of raw materials for the production of compound feed is waste obtained during the processing of sunflower and rapeseed (heads and stems) [11, 12].

The yield of heads per hectare is approximately 60% of the seed weight. With a sunflower seed yield of 12-15 centners per hectare, 7-

9 centners of heads are produced, or over 500 feed units., and 50 kg of digestible protein. This valuable feed is comparable in chemical composition to hay. 1 kg of baskets contains 0.4-0.5 feed unit and 30-35 g of digestible protein, as well as 3-4% fat, 1.7-2% calcium, 1% phosphorus, 40% nitrogen-free extractive substances and 25-30% fiber.

Dried sunflower stalks are comparable in nutritional value to good-quality winter straw. The best way to use sunflower waste in animal feed is to make flour. Sunflower waste flour is best used in granulated mixtures, comprising up to 40% of the ingredients by weight. Cattle can be fed 2.5-3 kg of sunflower waste per head per day.

The best way to use sunflower waste in animal feed is to make flour. Flour made from sunflower and rapeseed waste is best used in granulated mixtures, comprising up to 40% of the components by weight. Cattle can be fed 2.5–3 kg of sunflower waste per head per day. Furthermore, sunflower waste has been shown to contain pectin. During harvesting and threshing, the pectin content averages 25–26%.

Rapeseed and its derivatives are currently being considered as an alternative to expensive concentrated animal and plant feeds. This is due to the relatively low price of rapeseed products, along with their high concentration of metabolizable energy, essential amino acids, and polyunsaturated fatty acids. Despite the lower availability of some minerals in rapeseed compared to soybeans, the former is a better source of readily available calcium, iron, manganese, phosphorus, selenium, and magnesium than soybeans, while the latter is a better source of copper, zinc, and potassium [13, 14, 15].

Thus, the use of waste in modern feed production enables the advanced processing of raw materials, a reduction in the cost of production of primary products through the sale of additional products, an expansion of the range of modern feed, the development of domestic animal husbandry, and improved environmental safety of food and processing facilities [16, 17]. The deficiency of protein components in compound feed can be reduced by using by-products from food and processing industries. Rational use of waste in feed production will ensure a cumulative effect and help related industries reach new levels of development.

The aim of the research is to study the impact of compound feed with the introduction of non-traditional oilseed waste on the level of milk productivity and milk quality.

Materials and research methods

To achieve this goal, a scientific and economic trial was conducted at the Yntymak farm in the spring using the diet of dairy cows, according to the scheme

presented in Table 1. The trial lasted 60 days and utilized a balanced group method. 40 Black-and-White cows were selected for the trial based on age, productivity, physiological condition, and live weight, and were divided into four groups of 10 cows.

The differences in feeding were that in the first

control groups, feed was used in accordance with the technology adopted on the farm, and in the experimental groups, the animals received compound feed according to a developed recipe, in which grain raw materials were replaced with feed flour obtained from post-harvest waste of oilseed crops (Table 2).

Table 1. Scheme of scientific and economic experiment

Groups	Number of animals in a group, heads.	Feeding conditions
I – control	10	Basic diet (BD)
II - experimental	10	Basic diet + test diet (sunflower flour - 5%, safflower flour 2% by weight)
III - experimental	10	Basic diet + test diet (sunflower flour - 7%, safflower flour 3% by weight)
IV - experimental	10	Basic diet + test diet (sunflower flour - 10%, safflower flour 5% by weight)

Table 2. The recipe for compound feed for dairy cows

Components	Experienced recipes, %		
	1	2	3
Wheat	17,0	14,0	11,0
Corn	30,0	30,0	30,0
Barley	10,0	10,0	10,0
Wheat bran	16,0	16,0	16,0
Corn feed	10,0	10,0	10,0
Sunflower cake	5,0	5,0	5,0
Feed phosphate	2,0	2,0	2,0
Chalk feed	1,0	1,0	1,0
Table salt	1,0	1,0	1,0
Premix	1,0	1,0	1,0
Sunflower Waste Flour	5	7	10
Safflower Waste Flour	2	3	5

The average daily milk yield served as the primary indicator for calculating the feeding ration. Milk production was determined individually for each experimental cow twice daily, with an average milk sample collected. Protein and fat content in the milk were determined using a Lactan -4M milk quality analyzer.

Results and discussion

During the study, the experimental cows

were fed a commercial diet balanced in all nutrients. A well-balanced diet ensures lactating cows produce the maximum possible amount of milk. Feed intake also influences milk production.

Cow productivity can be assessed by both milk quantity and milk quality. The milk quality obtained from experimental animals is presented in Table 3.

Table 3. Quality indicators of milk from experimental cows

Indicators	Groups			
	Control	Experience I	Experience - II	Experience - III
Average daily milk yield per cow, kg	20.0±1.7	21.1 ±2.1	23.2 ±1.8	22.4 ±1.7
Gross milk yield per cow per experiment, kg	1200±2.0	1266±2.2	1392±2.0	1344±1.9
Mass fraction of fat, %	3.50±0.5	3.52±0.3	3.60±0.6	3.58±0.3
Protein content, %	3.20±0.3	3.26±0.3	3.28±0.5	3.25±0.5
Gross milk yield per cow of basic fat content for the experiment, kg	1235±2.9	1310±2.9	1473±3.2	1423±3.0

Analyzing the data in Table 3, we can conclude that the developed feeding formula for lactating cows increased productivity and improved milk quality. Average daily milk yield per cow was 20 kg in the control group, compared to 21.1, 23.2, and 22.4 kg in the experimental groups. The protein content in milk from cows in the control group was 3.2%. Experimental cows fed oilseed waste in their diets exceeded their control group counterparts by 1.5-2.5% in this indicator.

A trend toward an increase in fat mass fraction was observed in the milk of cows in experimental group 2, which was 2.8% higher than in the control. Cows in experimental groups 2 and 3 exceeded the control in terms of fat mass fraction by 2,5-3%. An increase in fat mass fraction was observed in the milk of cows in the experimental groups, which was 0.5-2.0% higher than in the control.

The results of the study showed that feeding lactating cows with the developed compound feed contributed to increased productivity and improved milk quality due to more efficient use of nutrients in the diet.

Conclusion

Thus, the results of the conducted studies indicate that the developed feed recipe for lactating cows contributed to increased milk production and improved milk quality. The highest average daily milk yield was recorded in the second experimental group, reaching 23.2 kg, a 16% increase compared to the control. The most important component of milk is complete proteins, which combine a vast number of properties important for humans. The highest protein content was found in the milk of cows in the second experimental group.

It was established that animals in the experimental groups had similar quality indicators to animals in the control groups.

Consequently, the newly developed recipe, which contains non-traditional raw materials, allows us to solve a number of important problems, reduce the proportion of valuable grain raw materials in the composition of compound feed, reduce their cost, increase biological value, and improve the environmental situation.

REFERENCES

1. Бауэр М.Ш., Окутаева С.Т. Оптимизация рациона кормления как фактор повышения эффективности производства мяса крс //Проблемы агрорынка. – 2017. №3. -С. 84-89.
2. Оспанова Ш. К., Капов С.Н., Бегалина А.А., Серикпаева Ж. К. Проблемы кормопроизводства в северномказахстане и пути выхода из кризисного состояния //Вестник науки Казахского агротехни-

ческого университета им. С.Сейфуллина (междисциплинарный). - 2022. - №3 (114). –Ч.1. - С. 131-143

3. Амантаева А.А., Батырбаева Н.Б., Алимкулов Ж.С. Применение побочных продуктов нетрадиционных масличных культур в производстве комбикормов //Вестник Алматинского технологического университета - 2025.-№1(147). -С. 123-130. <https://doi.org/10.48184/2304-568X-2025-1-123-130>

4. Мизанбекова С.К., Тиреуов К.М., Айтмуханбетова Д.А. Комбикормовая промышленность Республики Казахстан: тенденции модернизации //Проблемы агрорынка. -2022. -№4.- С.104-111. <https://doi.org/10.46666/2022-4.2708-9991.11>

5. Макарецов, Н.Г. Кормление сельскохозяйственных животных: учебник для вузов / Н. Г. Макарецов. - 4-е изд., испр. и доп. - Калуга : Ноосфера, 2017. - 640 с.

6. Жиенбаева С.Т., Жолдаспекова А.М. Перспективы использования отходов масложировой промышленности при производстве комбикормов//Вестник Алматинского технологического университета. -2013.- №2 (98) - С. 26-30.

7. Алимкулов Ж.С., Жиенбаева С.Т. Казахстан укрепляет кормовую базу//Комбикорма -2012. -№4. - С.21-22.

8. Василенко В. Н., Фролова Л. Н., Драган И. В. Технология переработки отходов масложировой промышленности РФ//Научно-методический электронный журнал «Концепт». – 2015. – Т. 13. – С. 2271–2275.

9. Курочкин А.А. Способ производства кормов из отходов животного и растительного происхождения с повышенной влажностью ингредиентов //Инновационная техника и технология.- 2019. -№ 2.-С. 21-24.

10. Абилов Б. Т., Крючков П. Г., Джафаров Н. М. Использование отходов подсолнечника в рационах откормочного молодняка крупного рогатого скота// Сельскохозяйственный журнал - 2004. -№2-2.

11. Бречко, Я. Н. Повышение эффективности возделывание рапса в Республике Беларусь // Сборник научных трудов «Проблемы экономики» – Горки: БГСХА. -2016. – № 2. – С. 3–15.

12. Могилатова Н. Ю., Соловьева Е. В., Ефименко Л. В. Корзинки подсолнечника - перспективное сырье при производстве комбикормов // Известия вузов. Пищевая технология. -2005. №5-6.

13. Егоров И.А., Андрианова Е.Н. Рапс в комбикормах для цыплят-бройлеров// Птицеводство. – 2012. – № 2. – С. 21–23.

14. Осепчук Д. В., Мартынеско Е. А. Рапсовые корма в рационах для животных // Актуальные проблемы интенсивного развития животноводства. - 2013. №16 (1).

15. Alvarez-Hess P.S., Jacobs J.L., Kinley R.D., Roque V.M., Neachtain A.S.O. Twice daily feeding of canola oil steeped with *Asparagopsis armata* reduced methane emissions of lactating dairy cows// Animal Feed Science and Technology Article 2023 DOI:10.1016/j.anifeedsci.2023.115579

16. Цай В. П. Переваримость и использование питательных веществ, энергии корма ремонтных бычков в зависимости от структуры рациона// Зоотехническая наука Беларуси: сб. науч. тр. – Жодино, 2013. – Т. 48, ч. 2. – С. 61-69.

17. Цай В.П. Отходы солодового произ-водства как компонент комбикормов при откорме молодняка крупного рогатого скота// Зоотехническая наука Беларуси. – 2024. -№2(59) - С.107-116.

REFERENCES

1. Baýer M.Sh., Okýtaeva S.T. Optimizatsiia ratsiona kormleniia kak faktor povysheniia effektivnosti proizvodstva miasa krs [Optimization of the feeding ration as a factor in increasing the efficiency of cattle meat production]// Problems of the agricultural market. - 2017. No. 3. -pp. 84-89. (In Russian)

2. Ospanova Sh. K., Kapov S.N., Begalina A.A., Serikpaeva J. K. Problemy kormoproizvodstva v severnomkazahstane i pyti vyhoda iz krizisnogo sostoiianiia [Problems of feed production in northern Kazakhstan and ways out of the crisis]// Bulletin of Science of the Kazakh Agrotechnical University named after S.Seifullin (interdisciplinary). - 2022. - №3 (114). – Part 1. - pp. 131-143. (In Russian)

3. Amantaeva A.A., Batyrbaeva N.B., Alimkýlov J.S. Primenenie pobochnykh prodýktov netraditsionnykh maslichnykh kýltýr v proizvodstve kombikormov [The use of by-products of non-traditional oilseed crops in the production of compound feeds]// Bulletin of the Almaty Technological University.- 2025.-№1(147). - Pp. 123-130. <https://doi.org/10.48184/2304-568X-2025-1-123-130> (In Russian)

4. Mızanbekova S.K., Tireýov K.M., Aıtmyhanbetova D.A. Kombikormovaia promyshlennost Respyblikı Kazahstan: tendentsii modernizatsii [Feed industry of the Republic of Kazakhstan: modernization trends]// Problems of the agricultural market. -2022. -No. 4.- pp.104-111. <https://doi.org/10.46666/2022-4.2708-9991.11>.(In Russian)

5. Makartsev, N.G. Kormlenie selskohoziastvennykh jivotnykh: ýchebnik dlia výzov [Feeding farm animals: a textbook for universities]/ N. Mr. Makartsev. - 4 ED., ISPR. and DOP. - Kaluga: Noosphere, 2017. - 640 p. (In Russian)

6. Jienbaeva S.T., Joldaspekova A.M. Perspektivy ispolzovaniia othodov maslojirovoi promyshlennosti pri proizvodstve kombikormov [Prospects for the use of waste from the fat and oil industry in the production of animal feed]// Bulletin of the Almaty Technological University. - 2013.- №2 (98)- pp. 26-30. (In Russian)

7. Alimkýlov J.S., Jienbaeva S.T. Kazahstan ýkrepliaet kormovýy bazý [Kazakhstan strengthens its food supply]// Compound feed -2012. -No.4. -pp.21-22.

8. Vasilenko V. N., Frolova L. N., Dragan I. V. Tehnologiiia pererabotki othodov maslojirovoi

promyshlennosti RF [Technology of processing waste from the fat and oil industry of the Russian Federation]// Innovative machinery and technology.- 2019. -No. 2.-pp. 21-24. (In Russian)

9. Kýrochkin A.A. Sposob proizvodstva kormov iz othodov jivotnogo i rastitelnogo proishojdeniia s povyshennoi vlajnostíy ingredientov [Method of production of feed from waste of animal and vegetable origin with high moisture content of ingredients] //Innovative machinery and technology.- 2019. -No. 2.-pp. 21-24. (In Russian)

10. Abilov B. T., Krýchkov P. G., Djafarov N. M. Ispolzovanie othodov podsolnechnika v ratsionah otkormochnogo molodniaka krýpnogo rogatogo skota [The use of sunflower waste in the diets of fattening young cattle] Agricultural magazine.- 2004. -№2-2. (In Russian)

11. Brechko, Ia. N. Povyshenie effektivnosti vzdelyvaniia rapsa v Respyblike Belarýs [Improving the efficiency of rapeseed cultivation in the Republic of Belarus]// Collection of scientific papers "Problems of economics" – Gorki: BHSА. -2016. – No. 2. – pp. 3-15. (In Russian)

12. Mogilatova N. Íy., Soloveva E. V., Efimenko L. V. Korzinki podsolnechnika - perspektivnoe syre pri proizvodstve kombikormov [Sunflower baskets are promising raw materials in the production of compound feeds]// Izvestiya vuzov. Food technology. -2005. №5-6. (In Russian)

13. Egorov I.A., Andrianova E.N. Raps v kombikormah dlia tsypliat-broilerov [Rapeseed in compound feed for broiler chickens]// Poultry farming, 2012, No. 2, pp. 21-23. (In Russian)

14. Osepchýk D. V., Martynenko E. A. Rapsovyie korma v ratsionah dlia jivotnykh [Rapeseed feed in animal diets]// Actual problems of intensive development of animal husbandry. -2013. №16 (1). (In Russian)

15. Alvarez-Hess P.S., Jacobs J.L., Kinley R.D., Roque B.M., Neachtain A.S.O. Twice daily feeding of canola oil steeped with *Asparagopsis armata* reduced methane emissions of lactating dairy cows// Animal Feed Science and Technology Article 2023 DOI:10.1016/j.anifeedsci.2023.115579.

16. Tsai V. P. Perevarimost i ispolzovanie pitatelnykh veestv, energii korma remonnykh bychkov v zavisimosti ot strýktýry ratsiona [Digestibility and use of nutrients and energy of repair bullhead feed, depending on the structure of the diet]// Zootechnical science of Belarus: collection of scientific tr. – Zhodino, 2013. – Vol. 48, part 2. – pp. 61-69. (In Russian)

17. Tsai V.P. Othody solodovogo proizvodstva kak komponent kombikormov pri otkormie molodniaka krýpnogo rogatogo skota [Malt production waste as a component of compound feed in the fattening of young cattle]// Zootechnical science of Belarus. – 2024. -№2(59) - Pp.107-116. (In Russian)