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Article

Development of Calf Feeding Rations Based on Tmr Technology and Assessment of Nutrient Supply (Using the Uzmu-25 Probiotic Preparation)

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Abstract: This article presents the results of developing feeding rations and assessing nutrient supply for local bulls and female calves of local origin and crossbreeds with Holstein cattle raised under household conditions in Furqat District, Fergana Region, using both traditional and Total Mixed Ration (TMR) feeding technologies. Rations developed for four experimental groups (I–IV) at 6, 9, 12, 15, and 18 months of age were analyzed. In addition, the age- and live-weight-based doses of the UzMU-25 probiotic feed additive newly introduced into the TMR rations, as well as the rationale for its use, were described. The calculations showed that although the traditional rations generally provided satisfactory levels of energy and protein, significant deficiencies were observed in sugar, starch, and crude fat, amounting to 190–250 g, 679–920 g, and 17–68 g, respectively. In the TMR rations, the differences between nutrient requirements and actual supply for almost all parameters were within 0.05–17 units, which can be considered physiologically insignificant. The UzMU-25 preparation was incorporated into the rations at a rate of 0.02 g/kg live body weight per day, corresponding to 3–7 g/head/day for male calves and 3–7.5 g/head/day for female calves. The preparation was thoroughly mixed into the ration with the aim of supporting intestinal microflora and improving nutrient digestibility. The results demonstrate the advantages of TMR technology, particularly when supplemented with the UzMU-25 probiotic, over traditional feeding in terms of nutrient balance and ration uniformity.

Keywords: Calves, TMR (Total Mixed Ration), traditional ration, nutrient balance, UzMU-25 probiotic, feed unit, digestible protein, mineral substances, crossbred female calves, intensive rearing technology.

1. Introduction

One of the most important factors in increasing meat productivity and reducing feed costs in livestock production, particularly cattle farming, is the development of scientifically based rations that correspond to the age, live body weight, and physiological requirements of animals [1]. The biological characteristics of calves associated with age—including a high intensity of metabolism, rapid development of muscle and bone tissues, and a high capacity for nutrient utilization—require particular attention to the nutritional adequacy of rations during intensive rearing [2].

Previous studies have emphasized that the amount of feed required to produce 1 kg of live weight gain in young animals increases considerably with age [3]. Therefore, achieving complete and balanced nutrient supply during the early stages of life is one of the most economically efficient approaches to animal production.

Under household conditions in the Republic of Uzbekistan, cattle are often fed using traditional, non-standardized feed resources such as hay, straw, green forage, and kitchen waste. When feed components are provided separately, animals can selectively consume individual feeds. As a result, the planned energy-protein and mineral-vitamin balance of the ration may be disrupted under practical conditions .

To overcome this problem, the Total Mixed Ration (TMR) technology, which is widely used internationally is of particular interest. TMR involves providing all components of the ration as a homogeneous mixture [4]. The main advantage of TMR technology is that it prevents animals from selectively consuming individual feed components and ensures that each mouthful contains approximately the same proportions of energy, protein, fiber, minerals, and vitamins. This, in turn, contributes to stabilization of rumen microbial activity and improvement of feed conversion.

In recent years, the enrichment of feed rations with probiotic preparations has also gained considerable scientific and practical importance. Probiotic supplements that support intestinal microflora and improve nutrient digestibility may contribute to better metabolism, enhanced immune function, and more efficient utilization of feed in young animals [5].

From this perspective, the inclusion of the locally produced UzMU-25 probiotic preparation as a supplement to TMR rations is of particular scientific interest, as it has been tested under local conditions and adapted for potential application in household livestock production.

Taking the above into consideration, the objective of this study was to comparatively analyze traditional and TMR-based feeding rations developed for local male calves and local and crossbred female calves raised under household conditions, assess their nutrient supply, and scientifically describe the rationale and dosage of the UzMU-25 probiotic preparation introduced into the TMR rations [6].

The analysis of scientific literature indicates that the nutritional adequacy and balance of livestock rations, including those of calves, are among the decisive factors determining animal productivity. U.N. Nosirov analyzed the factors influencing the development of cattle production in Uzbekistan and emphasized the importance of scientifically based utilization of local feed resources.

S.V. Azarov demonstrated that the use of silage prepared with preservatives increases the efficiency of dairy cattle production, supporting the importance of corn silage and haylage in TMR rations. According to L. Gorkovenko and V. Shostak the productivity of farm animals fed complete and balanced rations increased by an average of 8–11%, which was associated with adequate supplies of energy, protein, minerals, and vitamins in accordance with physiological requirements [7].

O.B. Gelunova as well as V.V. Gimranov, N.V. Fisenko, and R.R. Vakhitov reported that the inclusion of protein and biologically active feed additives in animal rations had positive effects on immune indicators and growth rates of young animals. These findings provide a scientific basis for supplementing TMR rations with probiotic preparations in the present study.

N.A. Kalashnikov, Kh.A. Amerkhanov, and V.I. Levakhin emphasized the need to introduce resource-saving and economically efficient feeding technologies in the development of beef cattle production.

Foreign researchers have also recently paid considerable attention to the inclusion of probiotic supplements in calf diets. In particular, a study by T. Liu, D.P. Casper, and J. Hu

reported that supplementation of weaned Holstein male calves with a probiotic preparation based on *Lactobacillus acidophilus* at approximately 5 g/head/day, corresponding to about 0.07 g/kg live body weight/day, resulted in significantly higher live body weight compared with the control group [8].

These findings indicate that the dosage range of the UzMU-25 preparation used in the present study, approximately 0.02 g/kg live body weight/day, falls within the practical range reported for probiotic feed additives in scientific literature.

2. Methods

For the experiment, 80 cattle were selected and divided into four experimental groups based on similarities in age, sex, origin, physiological condition, breed characteristics, and feeding system:

Group I — 6-month-old local male calves (n=10) and female calves (n=10), 20 animals in total, fed using the traditional feeding system;

Group II — 6-month-old local male calves (n=10) and female calves (n=10), 20 animals in total, fed using TMR technology;

Group III — 12-month-old local (n=10) and crossbred (n=10) female calves, 20 animals in total, fed using the traditional system;

Group IV — 12-month-old local (n=10) and crossbred (n=10) female calves, 20 animals in total, fed using TMR technology.

When formulating the rations, the daily physiological requirements of the animals were calculated for feed units, dry matter, digestible protein, crude fiber, sugar, starch, crude fat, calcium, phosphorus, carotene, and vitamin D based on the chemical composition and nutritional value of each feed component.

The analysis was conducted according to the principle of "requirement – supply – difference."

Traditional rations consisted mainly of green forage, wheat bran, kitchen waste, and common salt. To balance the TMR rations, haylage, corn silage, alfalfa hay, corn grain, cottonseed meal, tricalcium phosphate, and a 1% vitamin-mineral premix were additionally included.

At this stage of the study, the UzMU-25 probiotic preparation was additionally included in the TMR rations of animals in Groups II and IV. Its dosage was determined according to the animals' age and live body weight, at approximately 0.02 g/kg live body weight/day, based on the practical dosage range recommended for probiotic feed additives in the scientific literature. The preparation was thoroughly mixed into the ration. Feed intake and feed costs were determined by weighing the amount of feed provided and the remaining feed. The obtained data were statistically processed using computer-based methods according to the methodology of E.K. Merkureva.

3. Results

Composition of Traditional Feeding Rations

In Group I, traditional rations for 6-, 9-, and 12-month-old local male and female calves consisted mainly of green forage, wheat bran, kitchen waste, and common salt.

For male calves, the amount of green forage increased from 15.0 kg at 6 months to 20.0 kg at 12 months, bran increased from 1.4 kg to 2.2 kg, and kitchen waste increased from 2.5 kg to 3.0 kg. The total ration ranged from 18.90 to 25.24 kg.

For female calves, the corresponding amounts were 13.5–19.0 kg of green forage, 1.30–2.00 kg of bran, and 16.83–24.04 kg of total ration.

A similar trend was observed in Group III among 12-, 15-, and 18-month-old local and crossbred female calves [9]. The total ration for local calves ranged from 24.04 to 32.05 kg, whereas that of crossbred calves ranged from 25.94 to 34.45 kg.

Thus, the ration of crossbred female calves was 1.90–2.40 kg higher than that of local calves at each age stage, which may be associated with their higher growth rate and energy requirements.

The analysis of nutrient supply in the traditional rations (Tables 3.1.3 and 3.1.6) demonstrated that feed units, dry matter, digestible protein, crude fiber, calcium, phosphorus, carotene, and vitamin D were supplied above the required levels.

For example, digestible protein was supplied in excess by 176–404 g in male calves and by 150–333 g in female calves [10].

However, significant deficiencies were observed in easily digestible carbohydrates, particularly sugar and starch. Sugar deficiency amounted to 198–242 g in male calves and 190–250 g in female calves. The starch deficiency was even greater, amounting to 730–920 g in male calves and 679–903 g in female calves.

A deficiency of crude fat of approximately 17–68 g was also observed.

This situation can be explained by the predominance of bulky feed resources in the traditional ration and the insufficient supply of high-quality energy sources. Such an imbalance may negatively affect rumen microbial activity and energy metabolism.

TMR-Based Rations and Application of the UzMU-25 Preparation

To eliminate the deficiencies identified in the traditional rations, TMR-based rations were developed for Groups II and IV.

Haylage, corn silage, alfalfa hay, corn grain, cottonseed meal, tricalcium phosphate, and a 1% vitamin-mineral premix were included in the rations. At this stage of the study, the UzMU-25 probiotic preparation was also incorporated into the TMR rations [11].

The composition of these rations is presented in Tables 1 and 2.

Table 1. Composition of TMR Feeding Rations for Local Calves of Different Ages in Group II, Supplemented with UzMU-25 (n=20, per head per day)

Feed type	Unit	Male calves 6 months	Male calves 9 months	Male calves 12 months	Female calves 6 months	Female calves 9 months	Female calves 12 months
Haylage	kg	2.5	3.0	4.0	2.5	3.0	4.0
Corn silage	kg	3.0	4.0	5.0	3.0	4.0	5.0
Green forage	kg	7.5	8.0	8.0	7.0	7.5	8.0
Alfalfa hay	kg	1.2	1.5	2.0	1.0	1.2	2.0
Bran	kg	1.0	1.2	1.5	0.9	1.0	1.4
Corn grain	kg	1.1	1.4	1.8	1.0	1.3	1.7
Cottonseed meal	kg	0.35	0.45	0.60	0.30	0.40	0.55
Common salt	g	30	35	40	30	35	40
Tricalcium phosphate	g	40	45	50	40	45	50
Vitamin-mineral premix (1%)	g	20	25	30	20	25	30

Feed type	Unit	Male calves 6 months	Male calves 9 months	Male calves 12 months	Female calves 6 months	Female calves 9 months	Female calves 12 months
UzMU-25 probiotic	**g**	**3**	**4**	**5**	**3**	**3.5**	**4.5**
Total	**kg**	**16.65**	**19.60**	**22.94**	**15.74**	**18.44**	**22.65**

Table 2. Composition of TMR Feeding Rations for Local and Crossbred Female Calves of Different Ages in Group IV, Supplemented with the UzMU-25 Preparation (n=20, per head per day)

Feed type	Unit	Local 12 months	Local 15 months	Local 18 months	Crossbred 12 months	Crossbred 15 months	Crossbred 18 months
Haylage	kg	4.5	5.0	6.0	4.5	5.5	6.5
Corn silage	kg	5.5	6.0	7.0	5.5	6.5	7.5
Green forage	kg	8.0	8.5	9.0	8.5	9.0	9.5
Alfalfa hay	kg	2.0	2.5	3.0	2.0	2.5	3.0
Bran	kg	1.5	1.8	2.0	1.5	1.8	2.2
Corn grain	kg	1.8	2.0	2.5	1.8	2.2	2.8
Cottonseed meal	kg	0.60	0.70	0.80	0.60	0.70	0.90
Common salt	g	40	45	50	40	45	50
Tricalcium phosphate	g	50	60	70	50	60	70
Vitamin-mineral premix (1%)	g	30	35	40	30	35	40
UzMU-25 probiotic	**g**	**5**	**6**	**7**	**5.5**	**6.5**	**7.5**
Total	**kg**	**23.94**	**26.54**	**30.41**	**24.44**	**28.24**	**32.54**

As shown in the tables, the dosage of the UzMU-25 preparation was increased proportionally with the age and live body weight of the animals: from 3 g to 5 g in male calves of Group II, from 3 g to 4.5 g in female calves, from 5 g to 7 g in local female calves of Group IV, and from 5.5 g to 7.5 g in crossbred female calves [12]. In all cases, the dosage was approximately 0.02 g/kg live body weight per day, corresponding to the practical dosage range recommended for probiotic feed additives in the scientific literature. The preparation was not administered separately but was thoroughly incorporated into the TMR mixture as an integral component of the ration, thereby ensuring uniform distribution of probiotic microorganisms in each portion of feed. Its purpose was to support beneficial microflora in the gastrointestinal tract, improve the digestion and utilization of nutrients, and maintain the overall physiological condition of the calves [13].

Discussion

The analysis of nutrient supply in the TMR rations (Tables 3.1.4 and 3.1.8) demonstrated a marked difference compared with the traditional rations. In Group II, the

difference in feed units was only +0.04–0.06 kg, while the difference in digestible protein was +9–13 g and that in crude fiber was +12–17 g. The sugar deficiency was reduced to only −5–7 g, compared with −190–250 g in the traditional rations [14]. In contrast, starch was supplied in excess by +6–9 g, while the deficiency in crude fat was only approximately −2 g. Calcium and phosphorus were almost optimally balanced, with differences of +0.5–0.8 g and +0.4–0.6 g, respectively.

Similar results were obtained in Group IV: the difference in feed units was +0.05–0.08 kg, digestible protein was +12–16 g, sugar was −5–6 g, and starch was approximately +8–10 g. Thus, the use of TMR technology reduced the differences between nutrient requirements and actual supply to a physiologically insignificant level for almost all nutrient parameters [15]. This indicates that the rations were scientifically formulated and based on precise nutrient calculations.

Comparative Analysis of Traditional and TMR Rations

A generalized comparative analysis of the two feeding systems is presented in

Table 3. Comparative Analysis of Traditional and TMR Rations

Indicator	**Traditional ration**	**TMR ration**
Ration preparation method	Feeds are provided separately	All feeds are provided as a mixed ration
Feed intake	Selective feeding is possible	Complete ration is consumed
Energy supply	Incomplete	Balanced
Digestible protein	May be excessive or deficient	Standardized
Sugar	Deficient	Adjusted to the required level
Starch	Deficient	Adjusted to the required level
Calcium	Excessive in some cases	Standardized
Phosphorus	Imbalanced	Balanced
Carotene	High	Standardized
Vitamins	Dependent on natural sources	Supplied through the premix
Minerals	Incomplete	Supplied through tricalcium phosphate
Probiotic supplementation	**None**	**UzMU-25 probiotic used**
Ration uniformity	Low	High
Digestibility	Moderate	High
Feed consumption	Higher	Lower
Expected growth	Below the required level	Within the expected range

The data presented in the table show that, in traditional rations, the separate provision of feed components allows calves to selectively consume individual feeds, which may result in disruption of the planned nutrient balance under practical feeding conditions [16]. In the TMR system, all components, including the UzMU-25 probiotic, are provided as a homogeneous mixture, ensuring a relatively uniform intake of energy, protein, minerals, and probiotic microorganisms in each portion of the ration.

Scientific Basis for Additional Feed Components in TMR Rations

When TMR technology is used, each component added to the ration has a specific nutritional function (Table 4).

Table 4. Feed Components Added to the Ration When Using TMR Technology

Additional feed component	Reason for inclusion
Corn grain	Source of energy and starch
Cottonseed meal	Source of high-quality protein
Tricalcium phosphate	Regulation of the calcium-to-phosphorus ratio
Vitamin-mineral premix (1%)	Supply of vitamins and trace elements
Corn silage	Source of energy and digestible carbohydrates
Haylage	Source of bulky feed and energy
UzMU-25 probiotic	**Support of intestinal microflora and improvement of nutrient digestibility**

It can be seen that corn grain and corn silage serve to increase the energy and starch supply of the ration while cottonseed meal provides high-quality protein. Tricalcium phosphate and the vitamin-mineral premix contribute to restoring the mineral and vitamin balance [17]. Unlike the other components, the UzMU-25 probiotic preparation is intended not to alter the chemical composition of the feed but rather to improve the process of nutrient utilization in the animal's body. By supporting the activity of beneficial microflora in the gastrointestinal tract, it may enhance the digestibility of nutrients. Thus, in combination with other ration-balancing components, such as energy, protein, and mineral sources, the probiotic may exert a synergistic effect and contribute to improving the overall efficiency of the ration [18].

4. Conclusion

The results of the study demonstrated that traditional feeding rations used under household conditions generally satisfy the calves' requirements for energy, protein, calcium, phosphorus, carotene, and vitamin D. However, due to the predominance of bulky feed sources in these rations, considerable deficiencies in easily digestible carbohydrates, particularly sugar and starch, remained. The starch deficiency reached 730–920 g in male calves. Such an imbalance may adversely affect energy metabolism and rumen microbial activity and, consequently, may limit growth rates.

The rations formulated based on Total Mixed Ration (TMR) technology, incorporating haylage, corn silage, alfalfa hay, corn grain, cottonseed meal, tricalcium phosphate, and a vitamin-mineral premix, reduced the differences between nutrient requirements and actual nutrient supply to a physiologically insignificant level for all major nutritional parameters, generally within a few grams or hundredths of a kilogram. These results demonstrate the scientific basis of TMR technology for achieving a more balanced ration compared with the traditional feeding system.

At this stage of the study, the UzMU-25 probiotic preparation was additionally incorporated into the TMR ration, contributing to the qualitative enrichment of the diet. Its administration at age- and live-weight-adjusted doses (approximately 0.02 g/kg live body weight/day, corresponding to 3–7.5 g/head/day) and its thorough incorporation into the ration were intended to support intestinal microflora, improve nutrient digestion and utilization, and contribute to maintaining the overall physiological condition of the calves.

Thus, the combined application of TMR technology and the UzMU-25 probiotic preparation provides an opportunity to develop a balanced and scientifically based feeding system not only in terms of the chemical composition of the ration but also from the perspective of its biological effectiveness. The results indicate the practical potential of introducing this technology for intensive rearing of local and crossbred calves under household conditions and provide a reliable basis for further assessment of live weight gain, meat productivity, and economic efficiency in subsequent stages of the research.

REFERENCES

[1] National Academies of Sciences, Engineering, and Medicine, *Nutrient Requirements of Dairy Cattle*, 8th rev. ed. Washington, DC, USA: National Academies Press, 2021, doi: 10.17226/25806.

[2] R. L. Baldwin VI, K. R. McLeod, J. L. Klotz, and R. N. Heitmann, "Rumen development, intestinal growth and hepatic metabolism in the pre- and postweaning ruminant," *J. Dairy Sci.*, vol. 87, no. E-Suppl., pp. E55–E65, 2004.

[3] U. N. Nosirov, *Factors of Cattle Farming Development in Uzbekistan* (in Uzbek). Tashkent, Uzbekistan: SMI-ASIA, 2011.

[4] M. Siegmund-Schultze, B. Rischkowsky, I. Yuldashev, B. Abdalniyazov, and J. P. A. Lamers, "The emerging small-scale cattle farming sector in Uzbekistan: Highly integrated with crop production but suffering from low productivity," *J. Arid Environ.*, vol. 98, pp. 93–104, Nov. 2013.

[5] E. K. Miller-Cushon and T. J. DeVries, "Feed sorting in dairy cattle: Causes, consequences, and management," *J. Dairy Sci.*, vol. 100, no. 5, pp. 4172–4183, May 2017.

[6] D. J. Schingoethe, "A 100-year review: Total mixed ration feeding of dairy cows," *J. Dairy Sci.*, vol. 100, no. 12, pp. 10143–10150, Dec. 2017, doi: 10.3168/jds.2017-12967.

[7] Y. Uyeno, S. Shigemori, and T. Shimosato, "Effect of probiotics/prebiotics on cattle health and productivity," *Microbes Environ.*, vol. 30, no. 2, pp. 126–132, 2015, doi: 10.1264/jsme2.ME14176.

[8] M. L. Signorini, L. P. Soto, M. V. Zbrun, G. J. Sequeira, M. R. Rosmini, and L. S. Frizzo, "Impact of probiotic administration on the health and fecal microbiota of young calves: A meta-analysis of randomized controlled trials of lactic acid bacteria," *Res. Vet. Sci.*, vol. 93, no. 1, pp. 250–258, 2012, doi: 10.1016/j.rvsc.2011.05.001.

[9] L. S. Frizzo, M. V. Zbrun, L. P. Soto, and M. L. Signorini, "Effects of probiotics on growth performance in young calves: A meta-analysis of randomized controlled trials," *Anim. Feed Sci. Technol.*, vol. 169, no. 3–4, pp. 147–156, 2011, doi: 10.1016/j.anifeedsci.2011.06.009.

[10] U. N. Nosirov, *Cattle Farming* (in Uzbek). Tashkent, Uzbekistan, 2005, 383 pp.

[11] S. V. Azarov, "Improving the efficiency of dairy cattle production when using silages prepared with preservatives in rations," Abstract of Ph.D. dissertation, specialty 06.02.04, Volgograd, Russia, 2002, 25 pp. (in Russian).

[12] L. Gorkovenko and V. Shostak, "Success is largely determined by breeders," *Zhivotnovodstvo Rossii* [Animal Husbandry of Russia], no. 12, pp. 47–49, 2007 (in Russian).

[13] O. B. Gelunova, "A study of the growth and development of Kazakh White-headed and Kalmyk breeds and their crosses under the conditions of the Lower Volga region," *Sovremennye Problemy Nauki i Obrazovaniya* [Modern Problems of Science and Education], no. 3, pp. 1–7, 2012 (in Russian).

[14] V. V. Gimranov, N. V. Fisenko, and R. R. Vakhitov, "Immunological indices in bull calves after castration when using Vetosporin and Vitamelam," *Vestnik BGAU* [Bulletin of Bashkir State Agrarian University], no. 4, pp. 33–35, 2013 (in Russian).

[15] N. A. Kalashnikov, Kh. A. Amerkhanov, and V. I. Levakhin, "Beef cattle breeding: State, problems, and development prospects," *Molochnoe i Myasnoe Skotovodstvo* [Dairy and Beef Cattle Farming], no. 1, pp. 2–5, 2010 (in Russian).

[16] T. Liu, D. P. Casper, and J. Hu, "The effect of a phytobiotic, probiotic, and their combination as feed additives on growth performance of weaned Holstein male dairy calves," *Animals*, vol. 15, no. 8, Art. no. 1166, Apr. 2025, doi: 10.3390/ani15081166.

[17] M. A. Khan *et al.*, "Starch source evaluation in calf starter: I. Feed consumption, body weight gain, structural growth, and blood metabolites in Holstein calves," *J. Dairy Sci.*, vol. 90, no. 11, pp. 5259–5268, 2007.

[18] M. A. Khan *et al.*, "Starch source evaluation in calf starter: II. Ruminal parameters, rumen development, nutrient digestibilities, and nitrogen utilization in Holstein calves," *J. Dairy Sci.*, vol. 91, no. 3, pp. 1140–1149, 2008.