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Influence of Various Schemes of Feeding Calves with Whole Milk on their Growth Indicators and Physiological State

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Abstract: In dairy farming, special requirements are imposed on the feeding of replacement young animals. The period when young animals receive colostrum and milk is considered important for raising viable and productive animals. During this time, a large amount of whole milk is consumed by calves. In this connection, the purpose of our study was to compare the effect of various schemes of feeding calves with whole milk on their growth indicators and physiological state. The study was conducted in the Pobeda Limited Liability Partnership (Pavlodar region, Republic of Kazakhstan). The objects of the study were heifers of the Simmental breed. During the experiment, the authors evaluated the effect of the commercial (375 L) and reduced (345 and 285 L) whole milk feeding schemes on the subsequent growth and development of calves. In just 150 days of the experimental period, the highest average weight, as well as the largest absolute and average daily gains were noted in animals that received the least amount of milk according to the feeding scheme, which became possible due to the early and more intensive consumption of compound feed by calves of these groups. In total, in the group that received 375 L of milk, each calf received 160.97 kg of starter compound feed, in the group with 345 L of milk 176.45 kg of compound feed, and the group with 285 L of milk 215 kg of compound feed. Thus, with the same nutritional value of the diets, a decrease in the amount of whole milk fed to the calves of the experimental groups led to an increase in their consumption of compound feed, which, against the background of a normal physiological state and the absence of significant differences in the growth dynamics of experimental animals, makes it economically feasible to approach the use of such expensive feed as whole milk.

Keywords: Simmental Breed, Milk Feeding Schemes, Compound Feed, Growth Dynamics

Introduction

The effective functioning of modern dairy complexes with cows kept in cubicles is possible only with the organization of uninterrupted and complete feeding. The most optimal feeding type is the one where the cows receive the same type of homogenously mixed feed all year round. This feed should contain a full set of essential nutrients, which ensures stable milk productivity. The feeding process of the replacement calves is organized according to even stricter requirements. Starting from birth, it is necessary to take into account the biological features of the development of calves (Turzhigitova *et al*., 2021; Ateikhan *et al*., 2022; Reshetnikova and Krylova, 2022). The periods of their life when they receive colostrum and milk are considered important for the formation of viable animals (Vattio, 2007). Suffice it to say that passive immunity in newborn ruminants is formed solely due to the consumption of colostrum since the syndesmochorial placenta prevents the transfer of Immunoglobulins (Ig) from the mother to the fetus (Hannant, 2016; Fedorov *et al*., 2018). The next important stage in the formation of healthy and constitutionally strong young animals prepared for intensive use in

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industrial complexes is the dairy period of calf rearing (Bayazitova *et al*., 2023). As a rule, many dairy farms consume a large amount of whole milk for feeding calves, which leads to a decrease in its production and, as a result, a price rise. The problem is also aggravated by the fact that the content of fat, protein, and vitamin A in the milk of a lactating cow exceeds the actual norm for calves, is relatively unstable, and can cause digestive problems for them (Valoshin and Glazkov, 2022).

To reduce the consumption of whole milk for feeding calves, either its substitutes are used, or feeding rates are reduced with the simultaneous use of special compound feeds for calves (Bayazitova *et al*., 2023). In this connection, it is relevant to develop methods and feeding schemes for calves that allow reducing their consumption of whole milk, without reducing the intensity of their development.

The purpose of our study was to compare the effect of the use of various schemes of feeding calves with whole milk on their growth indicators and physiological state.

Materials and Methods

The study was conducted at the Angioinvasion and biotechnology science and research institute (NII) of Toraigyrov University and Pobeda LLP (Pavlodar region, Republic of Kazakhstan).

The objects of the study were heifers of the Simmental breed. For the experiment, according to the data of primary zootechnical and breeding records, as well as the results of visual assessment and weighing of newborn calves, three groups of animal analogs of 12 heads each were formed.

Up to 60 days of life, calves of all experimental groups were kept in individual cages and later they were transferred to small-group corrals. Colostrum was given to the calves during the first five days after birth and after that, they started receiving milk. In total, during the milk period, including the weaning period, the control (group I) calves received milk according to the scheme used in the farm in a total amount of 375 L, the 2nd (experimental) group received 345 L and the 3rd (experimental) group 285 L (Table 1). From 10-15 days of age, calves were gradually accustomed to compound feed and from 20 days of life to coarse feed. During the transition period, at the age of 46-120 days (calves of group 3) and from 61-120 days (calves of groups 1 and 2), the animals received starter feed and hay daily, and from 121-150 days and beyond (the growing period) they received a General Mixed Diet (GMD). At the age of 124-150 days, hay was replaced with green mass. The animals received water 2 times a day.

Starter compound feed for calves included the following ingredients (%): Corn: 19.3, feed wheat: 24.3, wheat bran: 14.3, barley: 14.3, sunflower cake: 24.3, tricalcium: 1.2, chalk: 0.8, salt: 0.5 and ToU premix: 1. Based on 1 kg of compound feed, the ToU premix includes fat-soluble vitamins: A: 1,400 thousand International Units (IU), D3: 300 thousand IU, E: 1 mg, macro-and microelements: Iron: 1 mg, magnesium: 5 mg, cobalt: 0.1 mg, manganese: 10 mg, sulfur: 10 mg and antioxidant Santoquin (ethoxyquin): 12.5 mg.

The dynamics of the live weight of experimental calves was determined from birth to 150 days by weighing them monthly on electronic scales for animals VTTP-1500 (Russia). Based on the data obtained, the average live weight and absolute and average daily gains were calculated. Nutritional analysis of feed was carried out by chemical methods: Total nitrogen according to Kjeldahl, crude fat according to Soxhlet, crude fiber by the Henneberg and Stohmann method, starch by the volumetric Pochinok method, sugar by the Bertrand and Bieri centrifuge method modified by E.A. Petukhova and digestible protein, Nitrogen-Free Extractive Substances (NFES) and exchange energy were determined by calculation method. Blood analysis of experimental animals included counting the number of Red Blood Cells (RBC) and White Blood Cells (WBC) in the Goryaev chamber, determination of Hemoglobin (Hb) on the CPK-3-01 ZOMZ photometer (Russia), determination of the Hematocrit (HTC) value by centrifugation and total protein on the IRF-454 B2M refractometer (Russia) (Kamyshnikov, 2009).

Statistical analysis of the sample data was calculated according to Student's t-criterion with a preliminary determination of the normality of distribution according to the Kolmogorov-Smirnov and Shapiro-Wilk test. In case of non-fulfillment of the assumption about the normal distribution of the aggregates from which the compared samples were taken, the nonparametric Mann-Whitney U-test (M-W U-test) was used, otherwise Student's t-statistics (Triolo *et al*., 2018).

Table 1: Scheme of feeding colostrum and milk to calves by periods

No.	Periods	Age, days	Maintenance period, days	Number of feedings per day	Scheme of feeding colostrum and milk, l		
					1	2	3
1	Colostrum	0-5	5	3	30	45	45
2	Milk	6-30	25	2	150	150	150
		31-45	15	1	105	90	90
3	Weaning	45-60	45	1	90	60	Water + Starter feed
Total		0-60	45	-	375	345	285

To determine the basic nutrients, blood parameters, and live weight indicators of three groups of calves, the Standard error (Sx) was determined as an indicator of the variability of the mean value of the attribute (X). The grouping of primary data and biometric calculations was carried out using Microsoft Excel and STATISTICA programs.

Results

The monthly nutritional accounting of diets for calves aged 1-5 months for all groups is presented in Table 2.

It can be seen that the level of raw and digestible protein in the calves' diets in all the age periods under consideration slightly exceeded the recommended values and the amount of raw fat and fiber, on the contrary, turned out to be below normal and significantly, if we talk about fat values. Some heterogeneity was noted in the actual content of starch and sugar in the diets. At the same time, the level of metabolizable energy, except for the diets of 3-month-old calves, only slightly differed from the recommended norms.

As for the assessment of the physiological status of experimental calves at different age periods, according to morphological (RBC, WBC, Hb, and HTC) and biochemical (total protein) blood tests, the diets used for feeding calves did not lead to any significant shifts in diagnostic results (Table 3) and all hematological parameters were within the normal range (Polozyuk and Ushakova, 2019).

In this regard, the data obtained on the growth dynamics of calves are more interesting (Table 4). At birth, the average live weight of calves of group 1 (control group) was 35.12±2.44 kg, the weight of the calves of group 2 (experimental group) was 34.31±2.51 kg and the weight of the calves of group 3 (experimental group) was 35.33±2.48 kg. Subsequent analysis of the weighing results shows that for 150 days of the experimental period, the highest average weight, as well as the largest absolute and average daily gains were noted in animals of the 3rd experimental group who received the least amount of milk according to the feeding scheme (285 L). This became possible due to the early and more intensive consumption of compound feed by calves of the 3rd experimental group. In total, the calves of this group ate 215 kg of compound feed against 160.97 kg in the control group and 176.45 kg in the 2nd experimental group (Table 5).

Accordingly, considering the amount of milk and feed spent on the calves, as well as the weight gain obtained, the scheme of feeding calves with 285 L of whole milk or, in terms of the cost, in the 3rd experimental group, the economic return for milk and feed costs was 52% higher compared to calves of the 2nd group and by 65% when compared with the control group.

Table 2: The content of basic nutrients in 1 kg of dry matter of calves' diets (X ± Sx)

	Age, months (n = 12)				
Indicator	1	2	3	4	5
Actual content					
Metabolizable energy, MJ	21.80±0.930	14.10±0.070	12.50±1.920	9.10±0.030	9.20±0.030
Crude protein, g	264.96±2.737	225.68±2.614	190.69±2.195	161.69±3026	171.30±3.133
Digestible protein, g	242.94±3.580	184.28±2.449	140.47±2.077	110.98±2.629	121.71±2.704
Crude fat, g	229.63±11.314	73.29±0.954	36.76±0.874	28.86±1.079	28.16±1.112
Crude fiber, g	22.58±3.917	100.63±2.796	158.91±2.076	178.33±3.082	195.54±4.162
NFES, including	453.47±21.650	523.76±0.762	537.98±0.220	555.63±1.435	510.51±2.350
Starch	51.71±7.895	145.02±3.557	171.18±5.377	178.70±3.095	184.42±1.811
Sugar	318.32±14.787	146.55±0.854	101.81±0.542	92.53±0.217	56.18±0.159
According to the recommended standards					
Metabolizable energy, MJ	21.11	15.47	9.33	9.35	9.34
Crude protein, g	240.44	216.67	165.67	154.71	146.05
Digestible protein, g	233.33	194.67	150.00	130.29	102.63
Crude fat, g	237.78	147.33	93.33	76.76	61.05
Crude fiber, g	81.11	143.33	200.00	217.65	190.28
Starch, g	-	250.86	139.33	140.00	133.16
Sugar, g	250.00	217.33	110.00	98.53	89.47

Table 3: Diagnostic parameters of calves' blood (X ± Sx)

	Group (n = 12)		
Calf age, days	1	2	3
RBC, million/µl			
20	7.55±0.40	8.12±0.23	7.48±0.12
60	8.30±0.11	7.90±0.15	7.67±0.23
80	7.97±0.08	7.73±0.10	7.80±0.19
100	7.02±0.15	6.82±0.24	7.03±0.10
WBC, thousand/µl			
20	8.28±1.38	7.96±0.85	7.08±0.46
60	9.20±0.77	8.45±0.74	10.13±0.81
80	11.78±1.38	8.20±0.68	9.70±1.43
100	10.10±1.36	7.65±0.70	8.65±0.66
Hemoglobin (Hb), g/l			
20	94.80±6.90	106.80±3.60	99.00±3.00
60	115.50±2.20	103.70±2.50	102.00±2.40
80	107.80±1.20	101.00±1.50	104.80±3.40
100	98.80±1.50	95.00±3.20	99.90±2.40
HTC, %			
20	37.80±1.92	41.00±1.35	37.20±1.73
60	42.17±0.81	39.83±0.64	39.00±0.81
80	39.25±0.49	38.50±0.24	38.25±0.97
100	34.75±0.49	34.75±0.49	36.25±0.24
Total protein, %			
20	6.96±0.16	6.77±0.14	6.73±0.16
60	7.16±0.11	6.75±0.17	6.47±0.66
80	7.47±0.14	7.13±0.17	7.26±0.19
100	6.92±0.12	7.13±0.17	7.04±0.07

Table 4: Dynamics of live weight indicators (X ± Sx)

	Age, months (n = 12)				
Group	1	2	3	4	5
Average live weight, kg					
1	57.08±9.74	80.25±10.4	102.33±10.84	126.67±16.91	155.85±19.91
2	56.52±8.09	79.51±9.28	102.41±11.27	127.47±16.30	157.16±17.22
3	57.69±7.53	78.77±8.02	105.60±12.14	136.70±12.30	167.40±13.76
Absolute gain, g					
1	21.96±0.58	23.17±1.25	22.08±1.91	24.34±1.490	29.16±2.250
2	22.21±0.42	22.95±1.25	22.90±1.58	25.06±1.410	29.68±1.830
3	22.36±0.42	21.08±1.41	27.10±0.75	31.10±1.990	30.70±2.580
Average daily gain, g					
1	708.40±41.5	747.40±41.5	788.5±66.50	785.1±49.90	972.70±74.80
2	716.50±33.8	741.60±41.6	817.9±58.20	808.4±41.50	989.00±58.20
3	721.30±33.8	680.00±41.5	967.9±33.80	1003.2±74.80	1023.30±83.10

Table 5: The economic effect of applying various schemes of milk feeding to calves

	Group (n = 12)		
Indicator	1	2	3
Milk consumed, kg	375.00	345.00	285.00
Cost of milk, tenge/kg	150.00	150.00	150.00
The total cost of milk, tenge	56,250.00	51,750.00	42,750.00
Cost of compound feed, tenge/kg	280.00	280.00	280.00
The total cost of compound feed, tenge	44,800.00	49,406.00	60,200.00
The total cost of all feeds, tenge	105,881.00	105,952.00	107,596.00
GMD spent, kg	37.00	37.60	36.20
Cost of GMD, tenge/kg	65.00	65.00	65.00

Table 5: Continue

Total cost of the GMD, tenge	2,405.00	2,444.00	2,353.00
Consumed green feed, kg	48.50	50.50	44.60
Cost of green feed, tenge/kg	40.00	40.00	40.00
The total cost of green feed, tenge	1,940.00	2,020.00	1,989.00
Hay consumed, kg	24.30	16.60	15.20
Cost of hay, tenge/kg	20.00	20.00	20.00
Total cost of hay, tenge	486.00	332.00	304.00
Compound feed consumed, kg	160.97	176.45	215.00
Weight gain for 150 days, kg	120.73	122.85	132.07
Cost of weight gain for 150 days, tenge/kg	1,000.00	1,000.00	1,000.00
The total cost of weight gain, tenge	120,730.00	122,850.00	132,070.00
Total cost (gain-feed), tenge	14,849.00	16,898.00	24,474.00
Total, %	100.00	113.00	165.00

Discussion

Feeding schemes and diets should ensure the normal growth and development of young animals following the accepted growth plans and feeding standards. It is necessary to economize expensive feed, especially milk. The combination of the biological features of the individual development of the animal with the possibility of using modern compound feeds for calves makes it possible to significantly increase the economic efficiency of raising replacement heifers (Sidorova, 2015; Sigidov and Korovina, 2015).

The data obtained in our experiment are consistent with the results of studies by other authors recommending a positive combination of diets with various schemes of feeding the calves with whole milk and early consumption of starter feed (Zelenkov *et al*., 2012). Thus, feeding high daily doses of milk (8-10 kg) and early use of plant feeds increased the live weight of calves by 11.415,1%, growth energy -by 13,2-16.5%, and reduced the cost of feed per 1 kg of body weight gain of 4.6-8,6% (Zelenkov *et al*., 2012). According to the results of our experiment, the calves of the experimental groups in all age periods had higher energy of live weight growth compared to the control group. From birth to 2 months of age, the growth rate of calves of the experimental groups increased, then from 2-3 months it decreased and from 3-5 months it increased again. The observed decrease in gains compared to the control group in calves of group 2 and especially group 3 (680 g/day) can be explained by an adaptive shift, since already next month, due to an increase in the consumption of concentrates, the animals of the experimental groups were able not only to catch up with the calves from the control group but also significantly exceed them in this indicator.

Some farmers who feed calves with various starter feeds and forage reduce the volume or concentration of whole milk fed, while others reduce the number of daily milk feedings (Palczynski *et al*., 2020). In our study, with the same nutritional value of diets, a decrease in feeding calves with whole milk in the experimental groups led to an increase in consumption of compound feeds by these calves, which, against the background of normal physiological state and the absence of significant differences in the growth dynamics of experimental animals, makes it economically feasible to approach the use of such expensive feed as whole milk.

The limitations of our study include that the study was conducted on heifers of the Simmental breed, which were fed with a compound feed of a certain composition. When studying heifers of a different breed and using compound feed with a different composition, the indicators may vary.

In further research, it is necessary to continue studying methods and feeding schemes for calves that allow them to reduce their consumption of whole milk, without reducing the intensity of their development.

Conclusion

The results of the feeding experiment conducted on young heifers from birth to 5 months of age allow us to draw the following conclusions:

1. Feeding calves less whole milk (by 8 and 24%) did not have a significant effect on their growth dynamics, as well as morphological and biochemical blood parameters
2. A decrease in the amount of whole milk fed to calves to 345 L and 285 L led to increased consumption of compound feed by calves of the experimental groups and an increase in their growth energy and weight gain compared to the control group by 1.76 and 9.39%, respectively

3. Taking into account the total costs of milk and feed, as well as the fact that the greatest gain was obtained in the group of calves who received up to 285 L of whole milk per head during the milk consumption period, this particular scheme of feeding with milk is the most optimal one

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Author's Contributions

All authors equally contributed to this study.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and that no ethical issues are involved.

Conflict of Interest

The authors declare that there is no conflict of interest.

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