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THE INFLUENCE OF DIFFERENT DIET FORMULATIONS ON THE REPRODUCTIVE QUALITY OF DRY COWS AND THE GROWTH OF THEIR OFFSPRING FROM THE NEW POPULATION OF SIMMENTAL BEEF CATTLE IN THE CARPATHIAN REGION OF BUKOVINA

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ABSTRACT

The aim of this study was to describe the effectiveness of feeding dry Simmental beef cows from the Bukovina zone of the Carpathian region with different diets and to analyze their effect on the growth of the offspring up to the age of 7 months. Significant changes in the live weight of bull calves were found at different ages (from birth to 7 months), indicating certain differences in the growth characteristics of the offspring whose dams received 15–20% more energy during the dry period. The economic efficiency of fattening young bulls from the new population of Simmental beef cattle fed haylage diets (providing 15–20% more energy for their dams during the dry period) is also presented. This feeding method has proven to be the most economically viable in the Carpathian foothill zone.

Key words: beef cattle, food dose, dry cows, calves, profitability

INTRODUCTION

In the circumstances of war, the need for further progress in feeding and behavioural analysis of the newly created Bukovina population of Simmental beef cattle has become one of the least important priorities, despite its long-standing presence in the Carpathian region of Ukraine. The regional programs for the development of the beef cattle industry, including the breeding of a new beef cattle population, have already been started [Pilarczyk et al. 2015]. However, minimal changes have been made in the approach to the clear definition of breeding goals, particularly in terms of efficient feeding systems and an analysis of offspring performance.

Undoubtedly, the proper feeding of the newly created cattle population, enhancing its high genetic potential for beef production during the war is among the leading directions to ensure profitability and competitiveness of the cattle industry in Western Ukraine, since genetically determined increase in productivity depends on the feed factor in the region [Romanzin et al. 2021]. Understanding of these relationships will enable selective breeding work to improve this trait [Mroczek and Mroczek 2018, Ustuner et al. 2020]. In the context of the financial and economic crisis, the experience of developed countries suggests that the production of high-quality beef can be achieved through the development and optimization of various diet formulations for Simmental beef cattle [Choroszy and Choroszy 2013, Ustuner et al. 2020]. Therefore, research on the theoretical and practical aspects of the newly designed diet formulations and feeding methods for dry beef cows and their offspring in stall housing is of utmost importance. It will ensure a high genetic potential for beef produc-

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tion under various ownership forms and climatic zones [Şenyüz et al. 2020], which is currently the most relevant solution for this region of Ukraine.

Based on the above, it is necessary to prepare new diet formulations, optimize feeding resources, and determine their effectiveness for Simmental beef cattle in the foothill zone of Bukovina. This approach, combined with the development of a promising and cost-effective beef cattle technology as an independent industry, is essential for the new population of Simmental beef cattle adapted to the requirements of the industry, particularly in terms of feeding, maintenance, and breeding, in various climatic zones of Ukraine.

Zootechnical literature has emphasized the importance of determining metabolizable energy concentration in dry matter for high growth rates in young animals [Bohdanov 1990]. Scientific and economic research on young Simmental beef cattle has been conducted in Dnipropetrovsk, Poltava, and Cherkasy, among others, [Hodovanets' and Kozyr 1988, Dorotiuk et al. 1996, Dorotiuk et al. 1998], highlighting the significance of appropriate feeding for daily weight gains throughout the rearing period. This relationship has been studied in Eastern Ukraine but not yet explored in the new population of beef cattle in the Carpathian region. In particular, Dorotiuk et al. [1996] proposed a new feeding system, which involved the use of the same type of winter feed produced on their own farm in the Kharkiv region throughout the year.

Meeting the mineral requirements of Simmental beef cattle is especially important [Vyshnevskyi 1997, Gurskyi 2001, Vasylets et al. 2009]. Therefore, homegrown feeds are provided by base farms breeding the new Bukovina population. Also, a relationship between body weight at 8 months and older ages is of practical importance when selecting animals for further breeding [Vynnychuk 1991, Uhnivenko 1995, Pabat 1997, Prudnikov 1998, Zubets et al. 2000]. The productivity of the new cattle population has already been examined at all developmental stages [Kalynka 2018, 2019a, 2019b, Kalynka et al. 2011, 2018, 2022b, 2022c]. However, information on various energy-saving feeding strategies, new cost-effective diet formulations and their optimization for beef production, is practically absent in the Carpathian region. Consequently, optimal feeding methods for farms under different ownership forms are currently developed in order to increase cattle growth dynamics, productivity, feed intake, and slaughter performance. New growth-enhancing diets include home-produced silage and haylage for complete nutrition during stall periods and summers with the maximum grazing on the newly established (in the foothill zone of the Carpathians) cultivated pastures containing legume-grass mixtures [Choroszy and Choroszy 2013]. Special emphasis is placed on obtaining quality feeds and feed mixtures from several plant species, which can provide well-digestible protein and other nutrients. Additionally, these feeds should be ecologically clean and cost-effective to procure.

Therefore, the aim of the present study was to analyze the effect of new diet formulations and the genetic potential of the offspring (from the new Bukovina population of Simmental beef cattle), whose dams received different levels of metabolizable energy three months before calving.

MATERIAL AND METHODS

The research was conducted at the breeding farm of the Bukovina State Agricultural Research Station of the Institute of Agriculture of the Carpathian region of the National Academy of Agricultural Sciences of Ukraine. It involved dry Simmental beef cows from the new Bukovina population. Three animal groups were selected, each containing 10 individuals with the same lactation period according to the developed scheme (Table 1).

Maintenance conditions for all experimental cows and their offspring were the same. Energy requirements were calculated based on actual nutritional values, taking into account metabolizable energy concentration per 1 kg of dry matter [Tsvihun et al. 2001]. Dry cows were housed in a stanchion barn during the stall period. Actual feed intake was calculated by the difference between feed provided and residual feed.

Table 1. The scheme of the scientific and economic study

Group	Gender	Number of animals	Features of animal feeding	
			Period	
			Preparatory (25 days)	Accounting
				Winter (60 days)
Control	Cows	10	Diet adopted on the farm	Basic ration (BR): maize silage, hay, straw, grain mixture (barley, maize), table salt
Experimental-1		10		BR + 15% hay by nutrient content
Experimental-2		10		BR + 20% hay by nutrient content

Table 2. The scheme of the scientific and economic study

Group	Gender	Features of animal feeding
		Accounting period
Control	Bull calves	Basic ration (BR): haylage, hay, grain mixture (barley, maize), milk, green mass
	Heifer calves	
Experimental-1	Bull calves	Same as in the control group
	Heifer calves	
Experimental-2	Bull calves	
	Heifer calves	

The offspring were grouped according to their gender and age (Table 2). The diets fed to their dams three months before calving contained different energy levels, according to the developed scheme. Each feed unit contained 100–120 g of digestible protein or 13–15 g of crude protein in the dry matter of the diet [Tsvihun et al. 1999, Ibatullin et al. 2003]. The energy content of each 100 g of dry matter was 0.85–1.0 MJ.

Recommendations for standardizing beef cattle feeding [Babych et al. 1998] were used for diet formulation [Tsvihun et al. 1999, 2001]. Feed consumption per group was determined by control feeding over two consecutive days once a week. During the experiment, diets were adjusted based on the age and live weight of the experimental animals. The average daily feed intake of cows three months before calving is presented in Table 3, whereas that of their offspring over the seven-month study period is shown in Table 4. The economic analysis was also conducted. Statistically significant differences were determined with one-way analysis of variance and Dunnett's post-hoc test for normally distributed data. Alternatively, Kruskal–Wallis and Dunn's tests were performed. Statistical significance was declared at $P < 0.05$. Statistica PL v. 13 [TIBCO Software 2017] was used for calculations.

RESULTS AND DISCUSSION

Average daily gain of the bull calves of the control group in winter and summer (over 221 days of the experiment) was 788.6 g, i.e. 85.8 g (10.9%) less than in the second experimental group (in which dams received 20% more metabolizable energy before calving), with the feed costs of 5.2 feed units (Table 5). In the study by Radkowski et al. [2016] on the feeding of different proportions of alfalfa mixed with meadow fescue to young Simmental cattle in the Holy Cross Voivodeship, Poland, average daily gains of the bull calves (initial body weight of 425 kg) were 894–1226 g, whereas those of the heifer calves (initial body weight of 360 kg) were 862–975 g. Sosin-Bzducha [2016] examined the fattening capacity of Simmental bull calves (mean birth weight of 41.9 kg) fed milk replacement, concentrate mix, hay, corn silage or haylage until 56 days of age. Bull body weight was determined at 3, 6, 12, 15, 18 and 24 months of age. The respective average daily gains were 638, 745, 992, 980, 962, and 939 g. In the study by Mroczek and Mroczek [2018] on 15 Simmental bull calves from Tarnow (Poland), the average body weight at slaughter at 22–24 months of age was 649 kg. On the other hand, Choroszy et al. [1995] found that the average body weight of Simmental calves at 10 days of age was 39 kg, their body weight at weaning was 172 kg and average daily gains from birth to weaning amounted to 947 g. Grodzki et al. [2015] reported that the average body weight of Simmental bull calves at 210 days of age in Poland was 296.1 kg and their average daily gains were 1229 g, whereas the respective values for Simmental heifer calves were 251.8 kg and 1015 g. Romanzin et al. [2021] examined residual feed intake in Italian Simmental bulls fattened for about 2 months. The average daily gain was 1570 g. In Turkey, Şenyüz et al. [2020] obtained the initial and final body weights of 430.6 and 632.0 kg, respectively, for Simmental cattle fattened for 195 days in a private farm of Çorum province, whereas Ustuner et al. [2020] reported the average daily gain of 1160 g for imported Simmental bulls, which ranged from 1140 to 1190 g depending on the initial body weight of the fattened animals.

A 15–20%-increase in the metabolizable energy caused by the addition of haylage to the diets for dry cows resulted in an average daily gain of 1075.9 g for the bull calves and 1095.6 g for the heifer calves up to the age of 2 months during the 54-day winter suckling period in the second experimental group. This daily gain was 278.2 g (34.9%) and 132.8 g (13.8%), respectively, higher than in the control group, whose dams were fed diets adopted in the farm. Feed costs per 1 kilogram of gain were 2.1 and 2.1 feed units, respectively, which were 0.8 and 0.3 feed units, respectively, lower than in the control group [Mamchak 1974, Mamchak and Kohut 1999]. Thus, the rearing of Simmental beef cattle with a 15–20%

Table 3. Average daily feed intake of beef cows during the main research period

Feed	Control	Experimental-1	Experimental-2
Hay, kg	1.5	2.5	3.5
Grain mixture, kg	2.0	2.0	1.0
Haylage, kg	20.5	20.5	20.5
Silage, kg	–	–	5.3
Diet composition:			
Metabolizable energy, MJ	97.89	104.7	125.5
Feed units, kg	8.16	8.41	8.05
Digestible protein, g	742.0	783.0	733.0
Dry matter, kg	12.1	12.9	12.3
Sugar, g	609.0	630.5	609.5
Calcium, g	22.8	29.9	34.1
Phosphorus, g	26.6	52.8	46.1
Digestible protein content:			
For 1 MJ, g	7.58	7.48	7.19
For 1 feed unit, g	90.9	93.1	91.05
For 1 kg of dry matter, g	61.3	60.7	59.6

Table 4. Average daily feed intake by young cattle over the entire seven-month study period

Feed	The features of animal feeding					
	Control		Experimental-1		Experimental-2	
	Bull calves	Heifer calves	Bull calves	Heifer calves	Bull calves	Heifer calves
Hay, kg	0.200	0.200	0.200	0.200	0.200	0.200
Grain mixture, kg	0.250	0.250	0.250	0.250	0.250	0.250
Haylage, kg	3.7	3.7	3.7	3.7	3.7	3.7
Green mass, kg	11.5	11.5	11.5	11.5	11.5	11.5
Whole milk, kg	3.29	3.29	3.29	3.29	3.29	3.29
Table salt, g	0.055	0.055	0.055	0.055	0.055	0.055
Diet composition:						
Metabolizable energy, MJ	68.85	68.85	68.85	68.85	68.85	68.85
Feed units, kg	4.1	4.1	4.1	4.1	4.1	4.1
Digestible protein, g	607.9	607.9	607.9	607.9	607.9	607.9
Dry matter, kg	4.5	4.5	4.5	4.5	4.5	4.5
Sugar, g	481.8	481.8	481.8	481.8	481.8	481.8
Calcium, g	25.8	25.8	25.8	25.8	25.8	25.8
Phosphorus, g	15.5	15.5	15.5	15.5	15.5	15.5
Digestible protein content:						
For 1 MJ, g	8.83	8.83	8.83	8.83	8.83	8.83
For 1 feed unit, g	126.4	126.4	126.4	126.4	126.4	126.4
For 1 kg of dry matter, g	135.1	135.1	135.1	135.1	135.1	135.1

higher metabolizable energy content in the dams' diet three months before calving contributed to a 13.8–35.0%

Table 5. Live weight and average daily gains of experimental animals ($M \pm m$, $n = 10$)

Indicator	Group					
	Control		Experimental-1		Experimental-2	
	Bull calves	Heifer calves	Bull calves	Heifer calves	Bull calves	Heifer calves
Number of animals	7	7	7	7	7	7
Live weight at the beginning of the study, kg	29.0 ±1.5	28.6 ±1.7	29.0 ±1.3	28.1 ±1.9	29.0 ±1.2	28.8 ±1.7
Live weight at the end of the winter period, kg	59.1 ±1.1	70.0 ±1.3	80.2 ±1.2	65.2 ±0.8	86.8 ±1.3	79.3 ±1.1
Total gain, kg	30.1 ±0.7	41.4 ±1.2	51.2 ±1.4	37.1 ±1.6	57.8 ±1.3	50.5 ±1.2
Average daily gain, g	797.7 ±0.025	962.8 ±0.045	1056.0 ±0.065	806.5 ±0.073	1075.9 ±0.084	1095.6 ±0.068
P	–	–	< 0.5	< 0.5	< 0.5	> 0.01
Feed consumption per 1 kg of gains, feed units	2.9	2.4	2.1	2.8	2.1	2.1
Live weight at the end of the study, kg	155.3 ±1.9	146.0 ±1.7	170.2 ±1.6	153.8 ±1.8	182.0 ±2.2	176.0 ±1.9
Total gain, kg	145.3 ±1.1	132.4 ±1.3	157.8 ±1.4	146.9 ±1.2	153.3 ±1.3	142.7 ±1.2
Average daily gain, g	788.6 ±0.065	689.6 ±0.045	826.7 ±0.055	769.1 ±0.065	874.4 ±0.075	898.4 ±0.063
P	–	–	< 0.5	< 0.5	< 0.5	> 0.01
Feed consumption for the entire period per 1 kg of gains, feed units	5.2	5.9	4.9	5.3	4.7	4.6

Table 6. Average body weight gains of bull calves ($M \pm m$, $n = 8$) from birth (0 months) to the raising completion at 7 months of age

Group	Age, months	Duration of the period, days	Live weight, kg		Absolute gain, kg	Daily gain, g	Relative growth rate, times
			Initial	Final			
Control	0–3	74	29.0 ±1.5	88.0 ±1.2	59.0 ±0.85	797.3 ±0.35	3.3
	0–7	221	28.6 ±1.7	174.3 ±1.5	145.3 ±1.1	788.6 ±0.25	6.0
Experimental-1	0–3	80	29.0 ±1.3	108.3 ±1.1	79.3 ±0.80	901.1 ±0.15	3.7
	0–7	192	28.1 ±1.9	186.8 ±1.2	157.8 ±1.1	821.8 ±0.20	6.4
Experimental-2	0–3	84	29.0 ±1.2	107.0 ±1.0	78.3 ±1.1	932.1 ±0.19	3.7
	0–7	231	28.8 ±1.7	182.0 ±1.2	153.3 ±1.0	874.4 ±0.23	6.3
P	–	–	–	< 0.5	–	< 0.5	–

increase in the average daily gains of their offspring compared to the control group.

During the 231 days of the main growth period, average daily gain of the bull calves of the second experimental group was 898.4 g, i.e. 109.8 g (13.9%) more than in the control group (P > 0.95). The final study period (177 days) involved the autumn pasture feeding on cereals and legume-grass mixtures, during which the bull and heifer calves from the second experimental group had average daily gains of 874.4 g and 898.4 g, respectively, which were 85.8 g (10.9%) and 208.8 g (30.3%), respectively, higher than those in the control group.

Changes in the live weight of Simmental beef bull calves from birth to 7 months of age indicated certain differences in the growth patterns of the offspring whose dams received 15–20% more energy three months before calving (Table 6). Despite an average feeding level, the bull calves from the pre-mountainous zone of Bukovina had relatively high daily gains. Metabolizable energy concentration, actual energy and dry matter intake per 100 kg of live weight in the heifer and bull calves for the entire research period are presented in Table 7. Metabolizable energy intake per 100 kg of live weight in the bull calves of the second experimental group was 37.8 MJ, i.e. 6.5 MJ (17.2%) less than in the

Table 7. Metabolizable energy and dry matter concentration per 100 kg of live weight for the entire study period

Group	Gains for the study period, kg	Metabolizable energy content per 1 kg of dry matter	Consumption per 1 kg gain		Intake per 100 kg live weight	
			Metabolizable energy, MJ	Feed units	Metabolizable energy, MJ	Dry matter, kg
Control						
Bull calves	145.3 ±1.1	15.3	114.5	6.5	44.3	2.9
Heifer calves	132.4 ±1.3	15.3	100.1	8.5	47.1	3.1
Experimental-1						
Bull calves	157.8 ±1.4	15.3	120.1	5.9	40.4	2.6
Heifer calves	146.9 ±1.2	15.3	111.7	6.9	44.8	2.9
P	< 0.05	–	–	–	–	–
Experimental-2						
Bull calves	153.3 ±1.3	15.3	127.0	5.4	37.8	2.5
Heifer calves	142.7 ±1.2	15.3	130.5	5.1	39.1	2.5
P	< 0.05	–	–	–	–	–

Table 8. Intake of energy, dry matter, protein, and concentrates per 1 kg of live weight gain

Indicator	Group					
	Control		Experimental-1		Experimental-2	
	Bull calves	Heifer calves	Bull calves	Heifer calves	Bull calves	Heifer calves
Dry matter, kg	5.7	6.5	5.4	5.8	5.1	5.0
Feed units	6.5	8.5	5.9	6.9	5.4	5.1
Digestible protein, g	773.4	881.5	735.3	790.4	695.2	676.6
Concentrates, kg	0.0031	0.0036	0.0030	0.0032	0.0028	0.0027
Metabolizable energy, MJ	114.5	100.1	120.1	111.7	127.0	130.5

Table 9. Economic efficiency of raising heifer calves

Indicator	Measurement unit	Experimental group		
		Control	Experimental-1	Experimental-2
Overall weight gain	q	662.0	1028.3	998.9
Per animal	kg	132.4	146.9	142.7
Average daily gain	g	793	840	894
Cost per 1 q of weight gain	FU	59.0	53.0	46.0
Value per 1 q of feed units	UAH	57.6	50.0	43.4
Gain value	UAH	2184	2184	2184
Per animal	UAH	4236.8	4700.8	4566.4
Per unit of protein	g	132.4	146.9	142.7
Cost of gain	UAH	1050	1050	1050
Profitability	%	34.6	47.7	34.9
Profit per 1 q	UAH	3186.3	3650.8	3516.4
Profit per animal	UAH	455.1	521.4	502.3

control group. Metabolizable energy intake per 1 kg of live weight gain in the bull calves of the second experimental group was 127.0 MJ (5.4 feed units), with a metabolizable energy concentration of 15.3 MJ per 1 kg of dry matter, which contributed to increased dry matter intake per 100 kg of live weight and cost-effective beef production in the Carpathian foothills [Kalynka et al. 2022a, 2022b, 2022c].

The intake of energy, protein, and feed per 1 kg of live weight gain by the heifer and bull calves is shown in Table 8. The bull calves of the second experimental group used 127.0 MJ of metabolizable energy, 5.1 kg of dry matter, 5.4 feed units, 695 g of digestible protein, and 0.0028 kg of feed per 1 kg of live weight gain, while the heifer calves utilized 130.5 MJ, 5.0 kg, 5.1 feed units, 677 g, and 0.0027 kg, respectively. Thus, feeding cows diets containing 20% more metabolizable energy for three months before calving resulted in the lower intake of digestible protein, feed units, dry matter, and metabolizable energy by their offspring (by 96.8 g, 1.4 units, 0.7 kg, and 15.0 MJ, respectively), making the developed feeding technology relevant for the Carpathian foothill region.

Radkowski et al. [2016] found that the Simmental bull calves from the Holy Cross Voivodeship used more feed and nutrients compared to the heifers (7.5 vs. 6.3 kg dry matter, 672 vs. 563 g protein digestible in the small intestine, 6.5 vs. 5.5 feed units for meat production). Feed and nutrient intake also increased with an increasing proportion of alfalfa in the diets (from 6.5 to 7.2 kg dry matter). Finally, the bull calves used feed and feed components less effectively than the heifer calves (7.2 vs. 6.8 kg dry matter, 608 vs. 593 g protein digestible in the small intestine, 6.27 vs. 6.0 feed units for meat production per 1 kg of weight gain). In the study by Romanzin et al. [2021], the average daily dry matter intake was 10.35 kg (corresponding to 2.58% body weight). Average feed efficiency in terms of the feed conversion ratio was 6.73 kg dry matter/kg body gain, and the residual feed intake ranged from –2.55 to +1.86 kg dry matter per day. Sosin-Bzducha [2016] found that the and the mean dry matter intake of Simmental bull calves was 8.49 kg.

The economic efficiency of raising heifer calves for the entire research period (per 1 feed unit/day) is presented in Table 9. The best economic indicators were achieved for the first and second experimental group, with the profits of UAH 521.4 and 502.3, respectively, and profitability of 47.7% and 34.9%, respectively.

CONCLUSIONS

The economic efficiency of fattening the new population of Simmental beef cattle using diets with a 15–20% higher energy content (through haylage addition) during the dry period made the above-described feeding method the most cost-effective in the Carpathian foothills.

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WPŁYW RÓŻNYCH DAWEK POKARMOWYCH NA CECHY ROZRODCZE KRÓW ZASUSZONYCH I WZROST ICH POTOMSTWA Z NOWEJ POPULACJI BYDŁA MIĘSNEGO RASY SIMENTALSKIEJ W KARPACKIM REGIONIE BUKOWINA

STRESZCZENIE

W artykule opisano efektywność żywienia krów zasuszonych nowej populacji mięsnego bydła simentalskiego różnymi dawkami pokarmowymi i ich wpływ na potomstwo do 7. miesiąca życia, z wykorzystaniem pastwisk zlokalizowanych na terenach podgórskich karpackiej Bukowiny. W badaniach stwierdzono istotne różnice masy ciała buhajków w różnym wieku (od urodzenia do 7. miesiąca życia), co wskazuje na pewne zmiany w charakterystyce wzrostu potomstwa, którego matki w okresie zasuszenia otrzymywały 15–20% więcej energii w dawce. Analizowano także efektywność ekonomiczną opasu buhajków nowej populacji bydła mięsnego z zastosowaniem dawek pokarmowych zawierających sianokiszonkę, które zwiększały pobranie energii w okresie zasuszenia o 15 do 20%. Opisana metoda żywienia okazała się najbardziej opłacalna w warunkach podkarpackich.

Słowa kluczowe: bydło mięsne, dawka pokarmowa, krowy zasuszone, cielęta, opłacalność

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