Scientific Papers. Series D. Animal Science. Vol. LXV, No. 1, 2022
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

THE INFLUENCE OF PROTEIN LEVEL IN DAIRY COW FEED ON THE PRODUCTION

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Abstract

Cattle are the most widespread category of domestic animals, with a special importance for the economy and agriculture of any country. Cattle produces 96% of the world's milk consumption, over 30% of meat and 90% of leather production. An important category in cattle is the "dairy cow", considered a living plant that transforms feed into animal products with a special nutritional value for human consumption. It is also an increasingly powerful "animal machinery", whose efficiency and productivity depend on its genetic background, diet and management. The present study showed that the level of protein in food can influence milk production.

Key words: *cow, feed ingredients, fresh category, milk.*

INTRODUCTION

Cattle farming is a major branch of world agriculture due to the volume, diversity and value of products and products obtained from this activity. In the EU agricultural sector, the productivity of the sector is very heterogeneous. In the next period, a further increase in the supply of milk and beef is expected (European Parliament's Committee on Agriculture and Rural Development, 2017). In the EU countries, most farms specializing in the production of milk and beef are located in Austria and Romania, in the mountainous areas of the Alps and the Carpathians (Figure 1).

In the food of the population of our country, food products of animal origin provide 25% of energy consumption, about 45% of daily consumption of protein and 50-56% of fat. Protein from beef products represents about 55-57% of the animal protein consumed by humans. The biological value varies depending on the nature of the product, meat or milk, between 74-82%, the digestibility coefficient is about 97%, the net use of protein is 70-77%, the protein having special qualities due to the balance in essential amino acids. The complex economic function of cattle also stems from the fact that they give very high yields per animal. In one year, milk is provided by a cow for lactation, a consumption for 12-14 inhabitants and an optimal meat consumption for 6-8 inhabitants (www.fao.org).

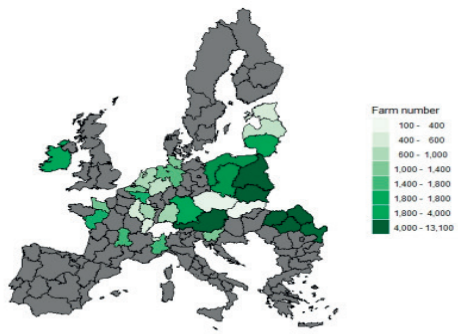

Figure 1. EU regional distribution of dairying and meat farms (European Parliament's Committee on Agriculture and Rural Development, 2017)

In Romania, cattle own about 41% of the herd expressed in UVM and share 50% in the value of global animal production, provide over 80% of total milk production, about 25% of meat production, 90% of total skins processed in the industry profile and about 70% of organic fertilizer (Georgescu coord., 2007; Maciuc et al., 2015). An important category in cattle is the "dairy cow", considered a living plant that transforms feed into animal products with a special nutritional value for human consumption (Georgescu coord., 2007; Fardet et al., 2019). Of the total production of cow's milk held in our country, 12% is technological consumption, 42% is consumed in the family, 25% is delivered directly to the market and only 21% is delivered to processing units (www.madr.ro).

MATERIALS AND METHODS

Ensuring the right protein quantity for high milk production dairy cows is a constant challenge for farmers (Dragomir et al., 2010; Arghiriade et al., 2013).

The aim of this study is to highlight the role of feed protein in dairy cows in the "fresh" category, which has the greatest impact on milk production and the reproductive cycle (Beever and Doyle, 2007; Salo, 2018).

The animals were followed from the moment of calving until the formation of the production batch. To carry out the experiment, two batches of Holstein dairy cows (Lot 1 and Lot 2) were made, each batch and which 21 animals. The 42 animals were chosen based on their physiological condition. Thus, it was intended that all cows be at a similar stage in terms of lactation. The analysed character was the daily milk production. The animals also benefited from the same accommodation conditions and maintenance throughout the experiment, the technological flow being the same for both batches of animals that were the subject of the experiment.

The measurement of the quantity of milk obtained during the differentiated feeding was done in 3 moments of lactation: at 14 days of lactation, at 21 days of lactation and at 45 days of lactation.

In the first 21 days after calving, for the duration of the “fresh” category, Lot 1 of animals was administered a ration with a protein content of 15.938% (A1 ratio) (Tables 1, 2), and Lot 2 of animals received a ratio of 17.019% (Ratio 2) protein content (Tables 3, 4).

Table 1. A1 ratio characteristics

Indicator	UM	Calculated value	Indicator	UM	Calculated value
Dry substance	g	18855.325	UDP/Crude protein	%	36.522
Crude fiber	g	3278.656	Energy metabolizable protein	Kcal	1837.275
Crude fat	g	814.209	Metabolizable energy based on Nitrogen	Kcal	1946.316
Ash	g	1376.997	Magnesium	g	61.9
Net Energy Lactation	MJ	123.667	Lysine	g	10.412
Crude protein	g	3005.124	Methionine	g	3.529
Ca	g	140.939	Zinc	mg	2550
Phosphorus	g	84.445	Copper	mg	550
Ca/P	%	1.669	Manganese	mg	2350
NaCl	g	62.6	Iron	mg	625
Fiber/dry substance	%	17.388	Cobalt	mg	14
Crude fat	g	814.209	Molybdenum	mg	187.5
Non-nitrogenous extractive substances	g	10380	Selenium	mg	12
Ash	g	1376.997	Iodine	mg	21
Energy concentration	MJ/kg	6.559	A-vitamin	NE	277500
Protein concentration	%	15.938	Energy for maintenance	MJ/kg	125.668
Protein balance	-	109.041	Energy for fattening	MJ/kg	79.513

Table 2. A1 ratio - Ingredients quantity

Crt. No.	Ingredients	Quantity (Kg)
1	Basic-Energy	1
2	Premix	0.25
3	wheat	1.4
4	Corn grain	3
5	Soybean meal.46%	1.3
6	Rapeseed meal	1.2
7	Alfalfa hay	2.5
8	Corn silage	20.4
9	Alfalfa semi-hay	7
10	Brewers grains	4
11	Urea	0.035
12	Sodium bicarbonate	0.1
13	Max-Fat-HP protected fat 99%	0.15
14	Salt	0.06

Table 3. A2 ratio characteristics

Indicator	UM	Calculated value	Indicator	UM	Calculated value
Dry substance	g	19820.275	UDP/Crude Protein	%	37.058
Crude fiber	g	3329.435	Energy metabolizable protein	Kcal	2017.349
Crude fat	g	1076.832	Metabolizable energy based on Nitrogen	Kcal	2208.006
Ash	g	1453.492	Magnesium	g	63.33
Net energy lactation	MJ	135.9	Lysine	g	14.767
Crude protein	g	3373.124	Methionine	g	4.524
Ca	g	143.179	Zinc	mg	2550
Phosphorus	g	89.565	Copper	mg	550
Ca/P	%	1.599	Manganese	mg	2350
NaCl	g	62.6	Iron	mg	625
Fiber/dry substance	%	16.798	Cobalt	mg	14
Crude fat	g	1076.832	Molybdenum	mg	187.5
Non-nitrogenous extractive substances	g	10587.391	Selenium	mg	12
Ash	g	1453.492	Iodine	mg	21
Energy concentration	MJ/kg	6.857	A-vitamin	NE	277500
Protein concentration	%	17.019	Energy for maintenance	MJ/kg	131.945
Protein balance	-	190.657	Energy for fattening	MJ/kg	83.773

Table 4. A2 ratio - Ingredients quantity

Crt. No.	Ingredients	Quantity (Kg)
1	Basic-Energy	1
2	Premix	0.25
3	Wheat	1.4
4	Corn grain	3
5	Soybean meal 46%	2.1
6	Rapeseed meal	1.2
7	Alfalfa hay	2.5
8	Corn silage	20.4
9	Alfalfa semi-hay	7
10	Brewers grains	6
11	Urea	0.035
12	Sodium bicarbonate	0.1
13	Max-Fat-HP protected fat 99%	0.4
14	Salt	0.06

After 21 days to 45 days of calving, a high production ratio with 15.983 % protein (A3 ratio) was administered to both groups (Tables 5, 6).

Table 5. A3 ratio characteristics

Indicator	U.M.	Calculated value	Indicator	UM	Calculated value
Dry subtance	g	24515.384	UDP/Crude protein	%	36.096
Crude fiber	g	4436.182	Energy metabolizable protein	Kcal	2437.654
Crude fat	g	1234.621	Metabolizable energy based on nitrogen	Kcal	2528.523
Ash	g	1612.378	Magnesium	g	77.74
Net lactation energy	MJ	167.282	Lysine	g	15.754
Crude protein	g	3918.208	Methionine	g	5.655
Ca	g	186.41	Zinc	mg	2550
Phosphorus	g	103.145	Copper	mg	550
Ca/P	%	1.807	Manganese	mg	2350
(NaCl)	g	81.8	Iron	mg	625
Fiber/dry subtance	%	18.096	Cobalt	mg	14
Crude fat	g	1234.621	Molybdenum	mg	187.5
Non-nitrogenous extractive substances	g	13313.995	Selenium	mg	12
Ash	g	1612.378	Iodine	mg	21
Energy concentration	MJ/kg	6.824	A-vitamin	NE	277500
Protein concentration	%	15.983	Energy for maintenance	mj/kg	162.771
Protein balance	g	90.869	Energy for fattening	MJ/kg	102.334

Table 6. A3 ratio - Ingredients quantity

Crt. No.	Ingredients	Quantity (Kg)
1	Premix	0.25
2	Wheat	2.5
3	Corn grain	4.4
4	Soybean meal.46%	1.8
5	Rapeseed meal	1.35
6	Alfalfa hay	3.6
7	Corn silage	23.5
8	Alfalfa semi-hay	9.5
9	Brewers grains	10
10	Urea	0.07
11	Sodium bicarbonate	0.15
12	Max-Fat-CS protected fat 84%	0.35
13	Max-Fat-HP protected fat 99%	0.25
14	Salt	0.08

The statistical analysis of data recorded during the experimental period highlighted the primary statistical parameters, as well as the significance tests of the obtained results (Fisher Test and Student Test).

The Student test was calculated according to the following formula (Sandu, 1995):

$$\hat{t} = \frac{\bar{X}_1 \cdot \bar{X}_2}{\sqrt{\frac{(\sum X_1^2 + \sum X_1^2)\cdot(n_1+n_2)}{(n_1+n_2-2)\cdot(n_1\cdot n_2)}}} \qquad (1)$$

The Fisher test was calculated by Analysis of Variance (Sandu, 1995) (Table 7).

Table 7. Analysis of Variance (ANOVA) parameters

Source of Variation	DF	SS	MS	F
Between Groups (I)	$DF_I = n-1$	$SS_I = \sum C - \sum TC$	$MS_I = SS_I / DF_I$	$F = MS_I / MS_i$
Within Groups (i)	$DF_i = p-1$	$SS_i = \sum X^2 - \sum TC$	$MS_i = SS_i / DF_i$	
Total	$DF_T = N - 1$	$SS_T = \sum X^2 - \sum C$	-	

NB: n - the total number of individuals in a group, p-the number of groups; N - the number of individuals; DF – degrees of freedom; SS – sum of square; MS – mean of squares; ∑C – sum of corrections; ∑TC – sum of total corrections; $\sum X^2$ – the sum of the values squared.

RESULTS AND DISCUSSIONS

The results obtained from the differentiated feeding of the two groups of dairy cows are shown in Tables 8 and 9. Regarding the calving situation, in Group 1, it was found that 85.71% of the animals gave birth normally and in group 2, the percentage was 95.24%.

Table 8. Evolution of milk production in Lot 1 of dairy cows

Crt. No.	Cow No.	Birth date	Calving situation	Milk production (l)		
				at 14 days	at 21 days	at 45 days
1	263	05.02.	Twin calving	19	24	27
2	583	10.02.	Normal	31	36	39
3	618	15.02.	Normal	29.9	34.9	37.9
4	789	16.02.	Normal	21.7	26.7	29.7
5	586	14.02.	Placental retention	2. 3	28	31
6	623	20.02.	Normal	19.6	24.6	27.6
7	77	20.02.	Normal	15.4	20.4	23.4
8	324	25.01.	Normal	24.6	29.6	32.6
9	266	01.01.	Normal	19.9	24.9	27.9
10	779	18.01.	Normal	28	33	36
11	791	18.02.	Placental retention	23.3	28.3	31.3
12	598	23.02.	Normal	27.2	32.2	35.2
13	408	24.02.	Normal	31.1	36.1	39.1
14	132	24.02.	Normal	22.8	27.8	30.8
15	796	25.02.	Normal	16.9	21.9	24.9
16	665	26.02.	Normal	23.1	28.1	31.1
17	797	28.02.	Normal	24.6	29.6	32.6
18	365	04.03.	Normal	25.3	30.3	33.3
19	799	05.03.	Normal	28.2	33.2	36.2
20	800	06.03.	Dead foetus	23.6	28.6	31.6
21	801	07.03.	Normal	31.4	36.4	39.4

Table 9. Evolution of milk production in Lot 1 of dairy cows

Crt. No.	Cow No.	Birth date	Calving situation	Milk production (l)		
				at 14 days	at 21 days	at 45 days
1	788	05.02.	Normal	24.8	29.8	32.8
2	612	05.02.	Normal	25	30	33
3	649	07.02.	Normal	26.1	31.1	34.1
4	382	06.02.	Normal	28.7	33.7	36.7
5	309	08.02.	Normal	23.6	28.6	31.6
6	211	10.02.	Normal	31.1	36.1	38.1
7	184	16.02.	Normal	40.1	45.1	48.1
8	790	17.02.	Normal	29.2	34.2	37.2
9	625	20.02.	Normal	23.4	28.4	31.4
10	792	22.02.	Normal	25.6	30.6	33.6
11	793	22.02.	Normal	30.7	35.7	38.7
12	659	07.03.	Normal	33.2	38.2	41.2
13	802	08.03.	Normal	35	40	43
14	632	09.03.	Normal	34	39	42
15	794	23.02.	Normal	33.6	38.6	41.6
16	795	23.02.	Normal	30	35	38
17	542	27.02.	Normal	43.9	48.9	51.9
18	420	28.02.	Normal	32.2	37.2	40.2
19	798	29.02.	Normal	32.1	37.1	40.1
20	804	15.03.	Normal	30	35	38
21	805	15.03.	Dead foetus	31.1	36.1	39.1

For a first comparison of the two groups of animals fed with rations with two different protein levels (15.983% and 17.019%), in the first 21 days after calving, it is necessary to know the statistics of the groups. Thus, the average milk production shows that there are quantitative differences between the two batches.

Depending on the number of days for which the quantity of milk obtained was measured, Lot 1 of dairy cows had an average quantity of milk of 24.25 l (at 14 days), 29.27 l (at 31 days) and 32.22 l (at 45 days). Lot 2 of dairy cows had an average amount of milk of 30.64 l (at 14 days), 35.62 l (at 31 days) and 38.59 l (at 45 days) (Table 10).

This difference can most probably be explained by the fact that the ration for Lot 2 was richer in protein when the cows were in the "fresh" category. Thus, the high level of protein provides the cow with the necessary to support a higher milk production.

The coefficient of variability decreases with the duration of lactation, which shows that the groups become more homogeneous after 45 days of lactation (Table 10). This is explained by the fact that the cow goes through the critical postpartum period.

Regarding the Analysis of Variance (ANOVA), concluded with the calculated Fisher value, it can be said that those between the two groups are very significant differences in terms of homogeneity of variants (Table 11).

Table 10. Primary statistical analysis of the two groups of animals

Lot 1			
Specification	Milk production at:		
days	14	21	45
The amount	509.6	614.6	677.6
Mediate	24.25	29.27	32.22
Standard deviation	4.63	4.60	4.57
Coefficient of variability	19.07%	15.82%	14.35%
Lot 2			
Specification	Milk production at:		
days	14	21	45
The amount	643.4	748.4	810.4
Mediate	30.64	35.62	38.59
Standard deviation	5.18	5.14	5.08
Coefficient of variability	16.90%	14.53%	13.42%

The significant difference noticed by the Fisher test shows that the different protein levels in the rations received by the two batches influence the milk production.

Table 11. Fisher's test to test the homogeneity of the variance for the two batches of dairy cows

Source	Degrees of freedom	The sum of the squares	Average squares	F-calculated	p-value	F-critical
Between groups	2	686	343	16.00909	2.68E-06 ***	3.150411
Enter groups	60	1285.52	21.42533	-	-	-
Total	62	1971.52	-	-	-	-

* - Significant; ** - Distinctly significant; *** -Very significant.

When the batches were compared in terms of the homogeneity of the media, it was observed that in all 3 combinations between the moments of lactation there are significant differences (Table 12).

The analysis of the homogeneity of group 2 shows that there are significant differences between the 3 moments of lactation in which the amount of milk was measured (Table 13).

Similar to batch 1, and in this case, it can be said that when the duration of lactation increases and the homogeneity of the variants between successive measurements increases.

Table 12. Student (t) test for homogeneity testing in Lot 1

Comparison	Number of days		
	14/21	14/45	21/45
t critical	2.02	2.02	2.02
t calculated	3.5	5.6	2.1
p - value	0.0011***	0.00000017 ***	0.042*

* - Significant; ** - Distinctly significant; *** - Very significant.

Table 13. Fisher's test for testing the homogeneity of the variance for Lot 2

Source	Degrees of freedom	The sum of the squares	Average squares	F-calculated	p-value	F-critical
Between groups	2	678.698413	339.3492	12.65051	2.61E-05 ***	3.150411
Enter groups	60	1609.49714	26.82495	-	-	-
Total	62	2288.19556	-	-	-	-

* - Significant; ** - Distinctly significant; *** - Very significant.

For Lot 2, the Student's test shows that there are significant differences in the comparison of milk production on day 14 with production on days 21 and 45, but there are no significant differences in the homogeneity of the averages when comparing milk production on day 14. 21 with milk production from day 45 (Table 14).

Table 14. Student (t) test for homogeneity testing in Lot 2

Comparison	Number of days		
	14/21	14/45	21/45
t critical	2.02	2.02	2.02
t calculated	3.12	4.97	1.84
p-value	0.003**	0.00000128 ***	0.072

* - Significant; ** - Distinctly significant; *** - Very significant.

CONCLUSIONS

Following this study and statistical analysis, the impact of protein levels in rations administered during the onset of lactation on milk production is highlighted, with higher milk production observed in cows given a higher protein ratio than those which had a lower protein ratio.

The differences in the quantities of milk obtained were given by the differences in protein in the two rations from the "fresh" period. These differences between milk production were maintained during lactation in high production.

The percentage of protein in the lactation onset ration is a determining factor in the amount of milk obtained later, provided that the rate is in an energy-protein balance.

The level of protein in rations given to lactating cows positively influences milk production by achieving high milk production.

ACKNOWLEDGEMENTS

This research work was carried out with the support of the Faculty of Animal Productions Engineering and Management, University of Agronomic Sciences and Veterinary Medicine of Bucharest, and is part of the elaboration of the doctoral thesis.

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