UDC 636.087:636.22/28

EXPERIMENTAL FOUNDATION OF NEW CONCEPTS OF BALANCING THE NEEDS OF ESSENTIAL AMINO ACIDS IN THE DIETS OF HIGH-PERFORMANCE DAIRY COWS

M. F. Kulik, Y. V. Obertyukh, O. Y. Beznosiuk

New principles of balancing the needs of essential amino acids for highly productive cows based on the fact that if milk yields are up to 20 kg of milk microbial protein provides all essential amino acids need, and at higher productivity calculated revenues only lysine and methionine in the composition of non-degradable protein mostly high-protein feed that comes from proventriculus to the small intestine for a given level of milk synthesis, because other essential amino acids are not critical at high their fermentation in the rumen.

Keywords: *essential amino acids, high-performance cows principles of balancing amino acids, feed, milk, microbial protein*

The norm of digestible crude protein per 1 feed. units. is 95 g daily milk yield up to 10 kg milk and increases to 105-110 g at milk yield of 20 kg or more. The demand for crude protein per 1 feed. units. for cows with daily milk yield up to 10 kg milk and 3,8-4,0% fat content is 145 g, with yields of 20, 30 or more of the same fat content respectively — 155, 160 and 170 g [6, 7].

Need cows in raw protein, which used for the synthesis of milk, is 82 g protein provided the content of milk is 3.2%, and provided the protein content of 3.4; 3.6 and 3.8%, respectively 86, 90 and 94 g. To determine standards for levels of crude protein in the diet of dairy cows must be considered degree of splitting proteins in the rumen. When using conventional diets it is based on a medium degree of splitting proteins, which equates to 84% [5].

On average, for every 100 grams of organic substances subjected to fermentation in the rumen, it is synthesizes of 20 g bacterial protein (protein), ago bacterial protein synthesis can vary from 400 to 1500 tons grams per day. The recommended concentration of crude protein in the diet of dairy cows can be from 12% in dry period and up to 18% of dry matter during early lactation. Provided that an average daily milk yield of 20-25 kg in diet contained 16% crude protein, then these conditions most voluminous high-quality forage and concentrates are adequate protein sources for the formation of milk. However, by increasing the production of milk synthesis of bacterial protein is insufficient, so it need additional sources of protein feed with low degree of splitting proteins in the rumen [3].

Thus, microbial protein of biomass of rumen provides a synthesis of milk at 20 kg daily milk yield. From other sources we know that per day in the rumen of a cow can be synthesized microbial protein 1.6 kg and some highly productive cows — 2.5 kg. Only about 30-40% protein of feeds of ration in non-degradable form reaches the small intestine, and the remaining 60-70% undergoes cleavage in the rumen and transformed into bacterial protein [2].

In 1 kg of dry matter of ration for high-performance cows with live weight of 600 kg and daily milk yield at 15, 20, 25, 30, 35 and 40 kg of milk norms lysine (g) is respectively 4.3; 5.0; 5.5; 5.9; 6.2 and 6.6, methionine and cystitis 1,4; 1,7; 1,9; 2,0; 2,1 i 2,3, histidine 1,6; 1,9; 2,1; 2,2; 2,3 i 2,4, leucine 4,7; 5,7; 6,3; 7,2 i 7,7 and isoleucine 2,5; 3,0; 3,3; 3,6; 3,9 i 4,1 [1].

Comparison of the protein content of essential amino acids in milk in graphical terms (Fig. 1) with the presence of the same acids in corn silage is almost identical pattern of its grain (Fig. 2). The high content of leucine and low lysine show that silage from corn as grain should be maximum exposes to fermentation in the rumen for microbial protein synthesis.

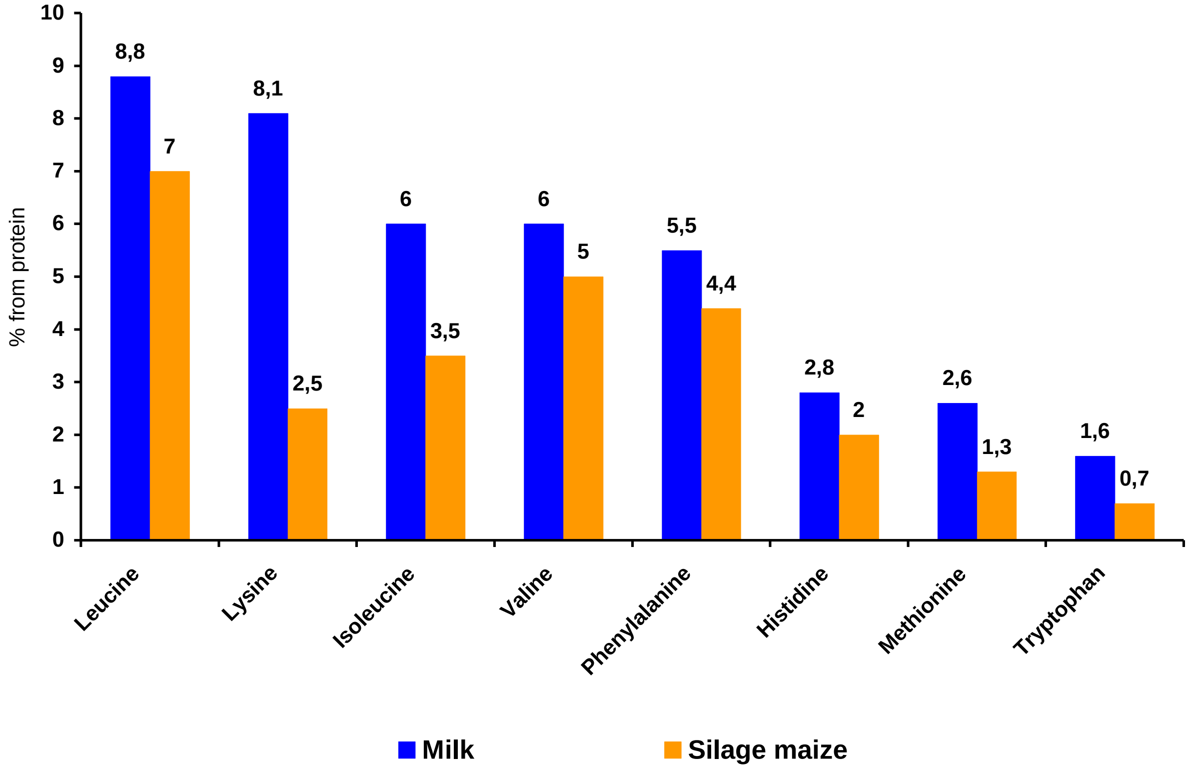

Fig. 1. The content of essential amino acids in the protein of milk and corn silage

During lactation mammary glands require a significant amount of amino acids, which have very complicated process of metabolism. Some amino acids can be converted to other or used for receiving energy during the oxidation, but the most convincing amino acids that are absorbed from the blood breasts are used for milk protein synthesis [3].

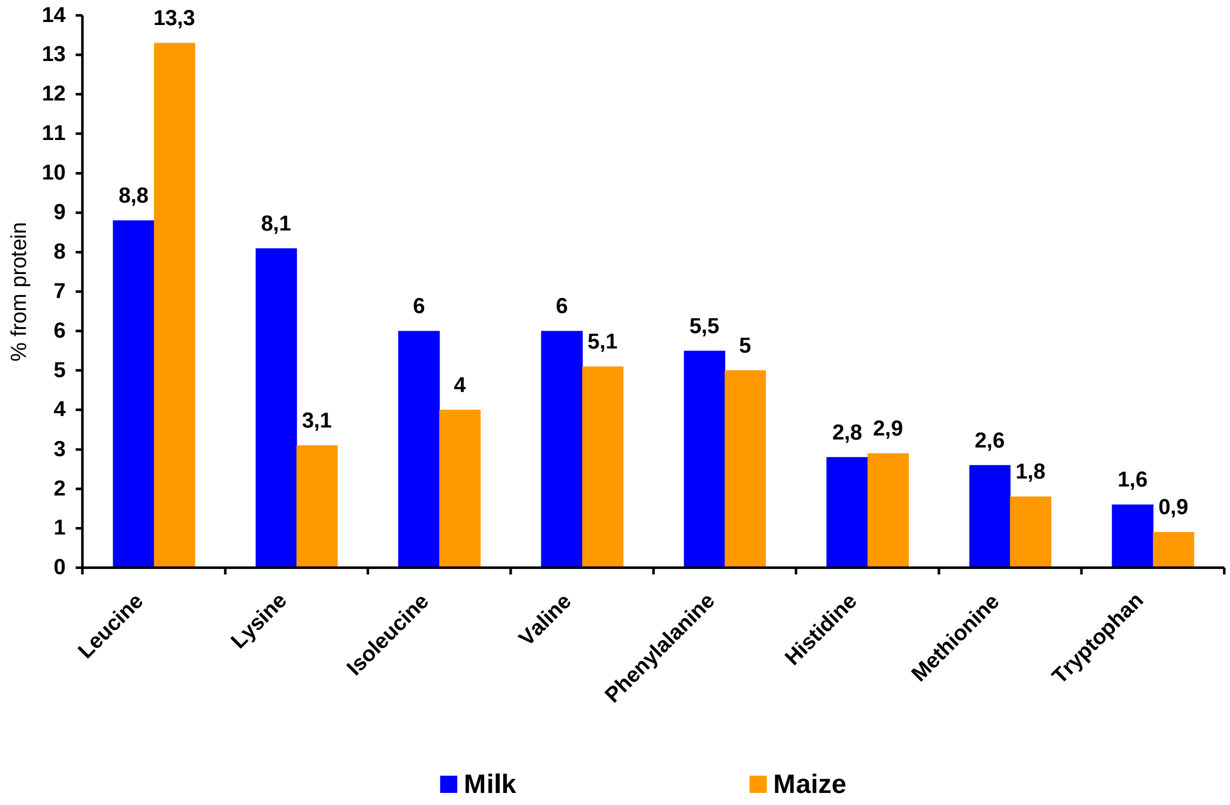

Fig. 2. The content of essential amino acids in the protein of milk and grain of corn

The protein that is cleaved in the rumen is a source of nitrogen for microorganisms that use it for the synthesis of amino acids and protein own and after splitting in the small intestine provides 50 to 90% of the required for cows in amino acids [8]. At high milk production milk protein synthesis from amino acids proteins of microorganisms is only 40-50% [4], the rest should be provided non-hydrolyzed in the rumen protein diet. In most cases, this cannot be achieved by the selection of feed. Therefore, in order to protect the protein from rumen splitting spend processing feed, especially high-protein, by various physical and chemical methods. One of the most common methods of reducing degree of splitting proteins is extrusion [9-11].

The analysis shows that balancing the needs of essential amino acids for highly productive cows from their total content in all feed ration is unfounded. Because bulky feeds are essential for the physiological functions of microbial protein synthesis and concentrated feed cereals have high degree of splitting proteins and must stimulate this synthesis. Grain soybean, peas, broad beans and sunflower meal must be subject heat-treated to reduce splitting in the rumen and increase fermentation in the gut for providing milk synthesis. Thus in the basis for balancing the needs of essential amino acids in the diets of high-performance dairy cows we laid the content of these acids in milk protein and rumen microbial protein (Fig. 3).

Comparative evaluation of the content of essential amino acids in the protein of milk and protein microbial shown in Fig. 3.

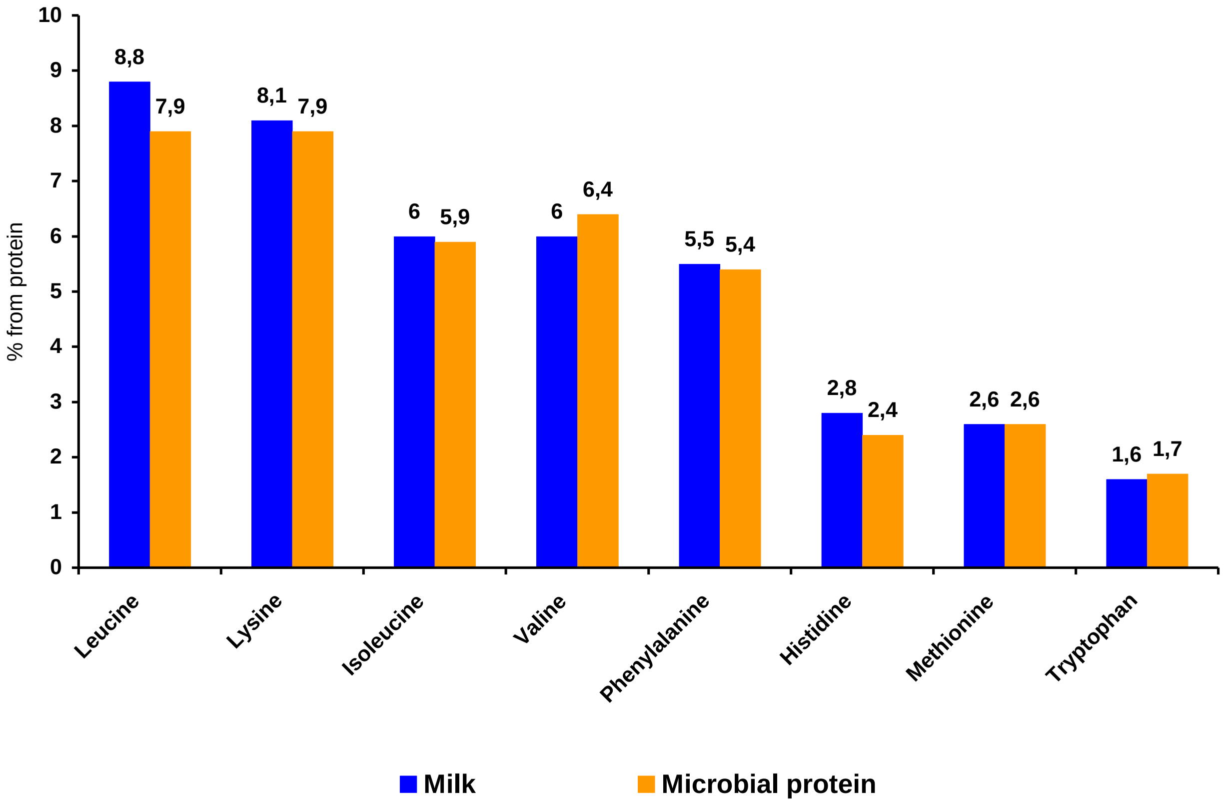

Fig. 3. The content of essential amino acids in the protein of milk and microbial protein

So the content of essential amino acids in the protein of milk exactly the same as containing the amino acids in the rumen microbial protein.

Materials and methods research. The basis for the research was the experimental farm "Olexandrivske" of Institute of feed and agriculture of Podol. On the farm had formed 3 technological groups of cows-analog black-and-white Ukrainian dairy breeds with a productivity of 30 liters of average yield. Cows were 2-3 months of lactation. Each group had 30 goals. Control milk yield was conducted each decade by 10 cows each group.

Rations the same type of feeding cows with daily milk yield of 30 kg of milk without and with the use of green mass of alfalfa when replacing part of silage are shown in Tables 1 and 2. In parallel, we analyzed the use of essential amino acids when the same type of feeding cows without feeding and when fed alfalfa green mass. The results of this analysis are presented in Tables 3 and 4.

Discharge with milk the essential amino acids from their content in diet without green mass and splitting under the same amino acids in the rumen indicates that lysine separated with milk 52%, and splitting it in the rumen is 48%, methionine in the same comparison 44 and 56%, tryptophan 34 and 66%, histidine 27 and 73%, leucine 23 and 77%, isoleucine 18 and 82%, phenylalanine 31 and 69%, threonine 34 and 66%, valine 29 and 71% (Table. 3 and 4). At the same time the content of essential amino acids in feed of both rations are given in the same Tables 3 and 4, and the content of essential amino acids in the milk of cows of different performance levels at 3.2% protein content are given in Table 5.

Analysis proceeds of essential amino acids in the intestine against the background of both diets suggests that lysine must enter the intestine respectively 52 and 47%, methionine 44 and 42%, tryptophan 34 and 29%, histidine 27 and 24%, leucine 23 and 22%, isoleucine 18 and 16%, phenylalanine 31 and 28%, threonine 34 and 30%, valine 29 and 27%.

If to draw an analogy between splitting crude protein feed of both rations and essential amino acids, which are listed in Tables 3 and 4, it is necessary to make a conclusion that cleavage at 70-80% corresponds to the process of digestion in the rumen of cows of high performance, but lysine and methionine are exception. Splitting crude protein ration of feed in the rumen of cows at splitting these amino acids 48-56% and 53-58% respectively as practically and theoretically impossible. We conclude that microbial protein synthesis in the rumen of high-performance cows need encouragement by voluminous and concentrated feed cereals.

The content of essential amino acids in sunflower meal on the graph (Fig. 4) along with the content of acid milk protein clearly shows that in cake the deficit of lysine and methionine because the synthesis of milk in the mammary gland of a cow will be held at lysine. Proof of this is coincidence content of essential amino acids in the protein and soy milk (Fig. 5).

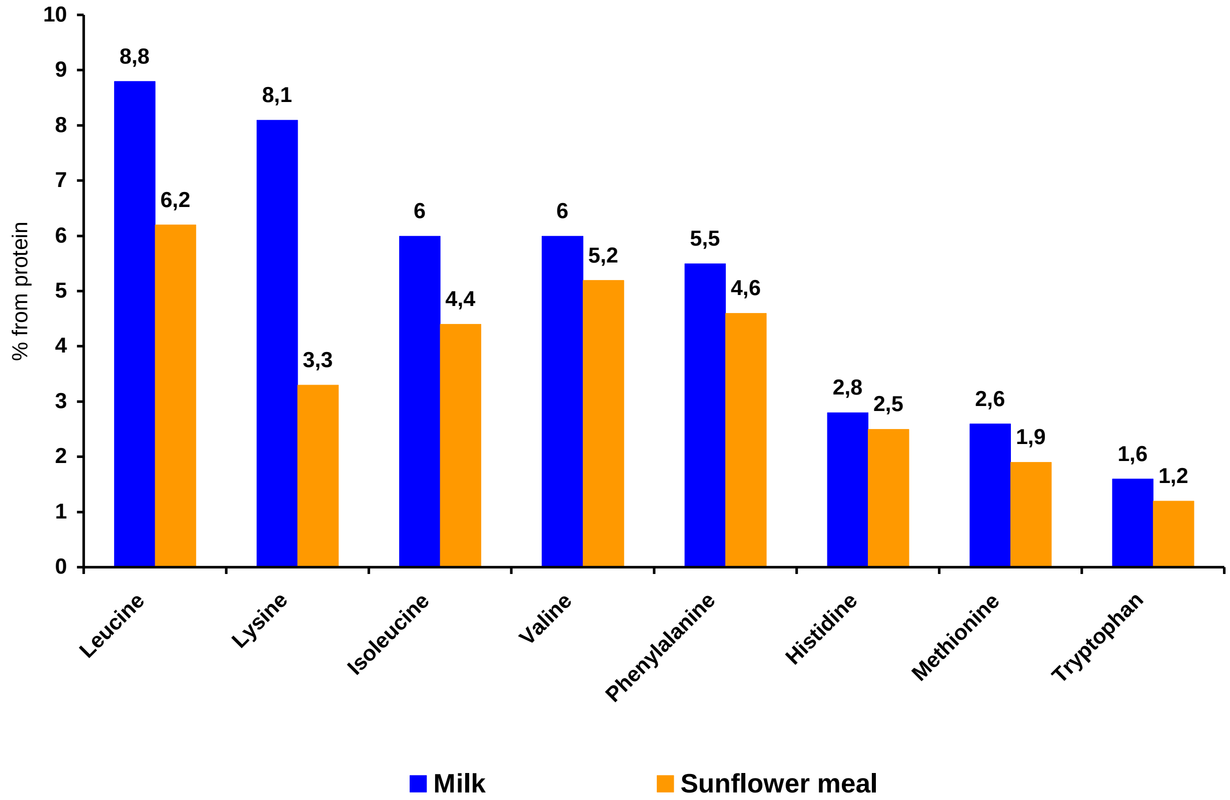

Fig. 4. The content of essential amino acids in the protein of milk and sunflower meal

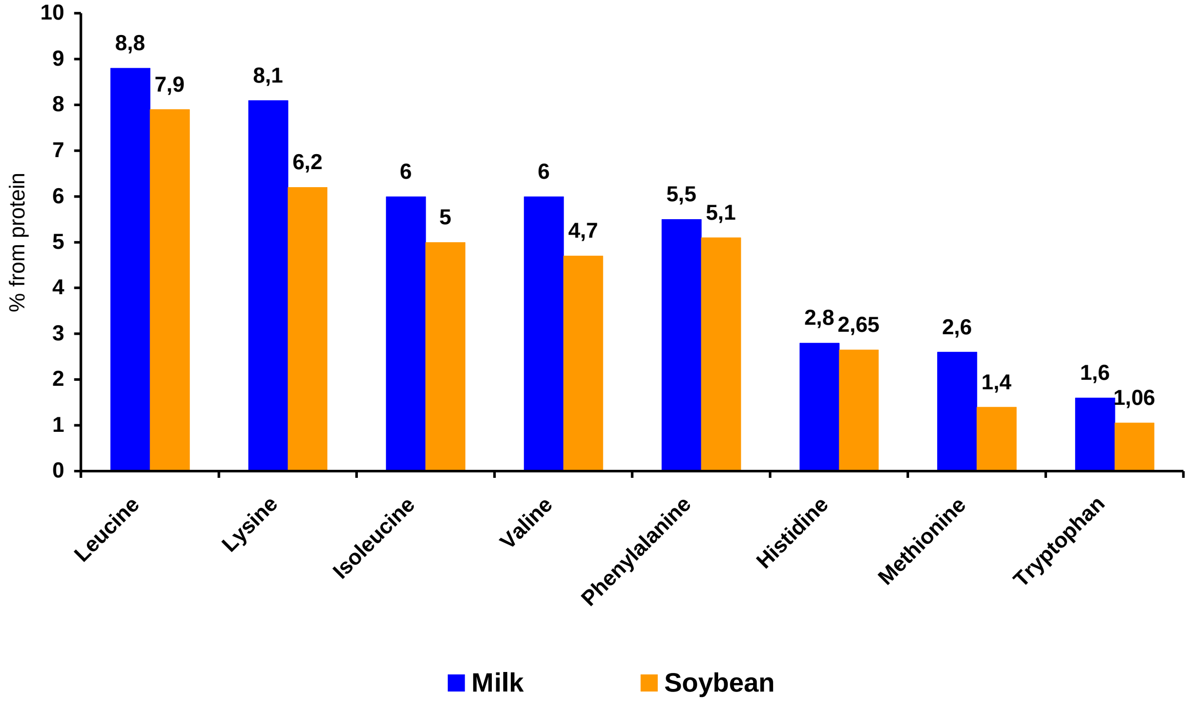

Fig. 5. The content of essential amino acids in the protein of milk and grain of soy

1. The diet of the same type of feeding of cows with daily milk yield of 30 kg of milk without the use of green mass

Signification	Silage corn	Haylage alfalfa	Hay alfalfa	Barley-wheat chaff	Fodder flour corn	Sunflower rape	Extrusions soybeans	Sal	Sodium bicarbonate	In all	Norm	+– to normal
kg	25	12	1	2	4	3,5	1,5	0,12	0,08	49,2		49,2
Feed units	5,0	3,84	0,56	0,68	4,32	3,5	2,2			20,1	19,9	+0,2
Energy exchange cattle, MJ	57,7	45,9	8,5	11,42	39,6	33,82	22,4			219,34	225	-5,66
Dry matter, g	6250	5400	830	1660	3400	3150	1350	0,108	0,072	22040,18	22100	-59,82
Crude protein, g	475	820,8	118,7	98	333,2	1134	405			3384,7	3215	169,7
Digestible protein, g	265	565,2	83,25	26	236,4	907,2	356,85			2439,9	2090	349,9
Crude oil, g	250	204	22	38	168	269,5	232,2			1183,7	715	468,7
Crude fiber, g	1875	1527,6	253	662	170	451,5	81			5020,1	4500	520,1
Starch, g	200	105,6	9	0	2240	87,5	30			2672,1	3135	-462,9
Sugar, g	150	192	20	4,8	80	219,1	150			815,9	2090	-1274,1
Ca, g	35	130,8	17	6,6	2	20,65	7,2		1,064	220,314	142	78,314
P, g	10	12	2,2	1,6	20,8	45,15	10,65		0,0496	102,4496	102	0,4496
Mg, g	12,5	10,8	3	2,2	5,6	16,8	4,35		5,28	14,52	35	-20,48
K, g	72,5	142,8	15,6	24,8	20,8	33,25	32,55		0,824	343,124	146	197,124
S, g	10	14,4	1,8	3,2	4	19,25	3,9			56,55	46	10,55
Fe, mg	1525	1512	168	746	1212	752,5	187,5		933,6	7036,6	1590	5446,6
Cu, mg	25	75,6	8,2	6	11,6	60,2	21,3		6,4	214,3	200	14,3
Zn, mg	145	110,4	19,1	40,4	118,4	140	49,5		128	750,8	1295	-544,2
Mn, mg	100	270	26,4	104	15,6	132,65	40,95		3,2	692,8	1295	-602,2
Co, mg	0,5	0,6	0,2	0,294	0,24	0,665	0,135			2,634	15,9	-13,266
I, mg	1,5	1,68	0,3	0,92	0,48	1,295	0,3			6,475	17,9	-11,425
Carotene, mg	500	480	49	8	27,2	7	0,3			1071,5	895	176,5
D, mg	1250	1980	360	20	0	17,5	0			3627,5	19,9	3607,6
E, mg	1150	300	134	0	90,4	38,5	54			1766,9	795	971,9

2. The diet of the same type of feeding of cows with daily milk yield of 30 kg of milk with replacement part of silage by green mass of alfalfa

Signification	Green mass of alfalfa (budding)	Silage corn	Haylage alfalfa	Hay alfalfa	Barley-wheat chaff	Fodder flour corn	Sunflower rape	Extrusions soybeans	Sal	Sodium bicarbonate	In all	Norm	+– to normal
kg	12	13	12	1	2	4	3,5	1,5	0,12	0,08	49,2		49,2
Feed units	2,16	2,6	3,84	0,56	0,68	4,32	3,5	2,2			19,86	19,9	-0,04
Energy exchange cattle, MJ	25,56	30,0	45,9	8,5	11,42	39,6	33,82	22,4			217,2	225	-7,8
Dry matter, g	2772	3250	5400	830	1660	3400	3150	1350	0,108	0,072	21812,18	22100	-287,82
Crude protein, g	600	247	820,8	118,7	98	333,2	1134	405			3756,7	3215	541,7
Digestible protein, g	468	137,8	565,2	83,25	26	236,4	907,2	356,85			2780,7	2090	690,7
Crude oil, g	108	130	204	22	38	168	269,5	232,2			1171,7	715	456,7
Crude fiber, g	684	975	1527,6	253	662	170	451,5	81			4804,1	4500	304,1
Starch, g	0	104	105,6	9	0	2240	87,5	30			2576,1	3135	-558,9
Sugar, g	168	78	192	20	4,8	80	219,1	150			911,9	2090	-1178,1
Ca, g	66	18,2	130,8	17	6,6	2	20,65	7,2		1,064	269,514	142	127,514
P, g	7,2	5,2	12	2,2	1,6	20,8	45,15	10,65		0,050	104,850	102	2,850
Mg, g	8,4	6,5	10,8	3	2,2	5,6	16,8	4,35		5,28	14,52	35	-20,48
K, g	63,6	37,7	142,8	15,6	24,8	20,8	33,25	32,55		0,824	371,924	146	225,924
S, g	16,8	5,2	14,4	1,8	3,2	4	19,25	3,9		0	68,55	46	22,55
Fe, mg	1152	793	1512	168	746	1212	752,5	187,5		933,6	7456,6	1590	5866,6
Cu, mg	26,4	13	75,6	8,2	6	11,6	60,2	21,3		6,4	228,7	200	28,7
Zn, mg	67,2	75,4	110,4	19,1	40,4	118,4	140	49,5		128	748,4	1295	-546,6
Mn, mg	163,2	52	270	26,4	104	15,6	132,65	40,95		3,2	808	1295	-487
Co, mg	0,6	0,26	0,6	0,2	0,294	0,24	0,665	0,135			2,994	15,9	-12,906
I, mg	0,204	0,78	1,68	0,3	0,92	0,48	1,295	0,3			5,959	17,9	-11,941
Carotene, mg	636	260	480	49	8	27,2	7	0,3			1467,5	895	572,5
D, mg	60	650	1980	360	20	0	17,5	0			3087,5	19,9	3067,6
E, mg	600	598	300	134	0	90,4	38,5	54			1814,9	795	1019,9

3. The use of essential amino acids of feed ration on milk synthesis by the same type of feeding of cows without feeding green weight (g)

Signification	Feeding, kg	Lysine	Methionine	Tryptophan	Histidine	Leucine	Isoleucine	Phenylalanine	Threonine	Valine
Silage corn	25	15,0	7,5	4,0	11,8	61,3	61,3	25,5	17,3	29,5
Haylage alfalfa	12	32,2	7,7	12,2	18,8	71,4	71,4	29,5	30,6	41,0
Hay alfalfa	1	6,1	1,2	0	3,6	13,7	13,7	7,7	0	6,1
Barley-wheat chaff	2	2,5	0,6	0	2,4	3,2	3,2	1,6	1	1,1
Fodder flour corn	4	11,2	6,4	3,2	10,4	48,0	14,4	18,0	12,8	18,4
Sunflower rape	3,5	51,5	27,0	19,6	41,0	130,2	130,2	62,3	53,6	74,9
Extrusion soybeans	1,5	31,5	6	5,4	13,5	40,5	25,5	26,1	21,0	24
Sal	0,12									
Sodium bicarbonate	0,08									
In all	49,2	149,9	56,3	44,4	101,5	368,2	319,6	170,7	136,2	195,0
% discharge from the milk of content in the diet		52	44	34	27	23	18	31	34	29
% cleavage of amino acids in the rumen		48	56	66	73	77	82	69	66	71
% flow of amino acids in the intestine		52	44	34	27	23	18	31	34	29

4. The use of essential amino acids of feed ration on milk synthesis by the same type of feeding of cows when fed green weight (g)

Signification	Feeding, kg	Lysine	Methionine	Tryptophan	Histidine	Leucine	Isoleucine	Phenylalanine	Threonine	Valine
The green mass of alfalfa (budding)	12	25,2	6,0	9,6	14,8	55,9	55,9	28,1	24,0	32,2
Silage corn	13	7,8	3,9	2,1	6,1	31,9	31,9	13,3	9,0	15,3
Haylage alfalfa	12	32,2	7,7	12,2	18,8	71,4	71,4	29,5	30,6	41,0
Hay alfalfa	1	6,1	1,2	0	3,6	13,7	13,7	7,7	0	6,1
Barley-wheat chaff	2	2,5	0,6	0	2,4	3,2	3,2	1,6	1,0	1,1
Fodder flour corn	4	11,2	6,4	3,2	10,4	48	14,4	18	12,8	18,4
Sunflower rape	3,5	51,5	27,0	19,6	41,0	130,2	130,2	62,3	53,6	74,9
Extrusion soybeans	1,5	31,5	6	5,4	13,5	40,5	25,5	26,1	21	24
Sal	0,12									
Sodium bicarbonate	0,08									
In all	49,2	167,9	58,7	52,1	110,6	394,7	346,1	186,6	151,9	213,0
% discharge from the milk of content in the diet		47	42	29	24	22	16	28	30	27
% cleavage of amino acids in the rumen		53	58	71	76	78	84	72	70	73
% flow of amino acids in the intestine		47	42	29	24	22	16	28	30	27

5. The content of essential amino acids in cow milk (g) with the protein content of 3.2%

The amino acid	Hopes (L)		
	28	29	30
Lysine	73,08	75,69	78,3
Methionine	23,24	24,07	24,9
Tryptophan	14,0	14,5	15,0
Histidine	25,2	26,1	27,0
Leucine	79,24	82,07	84,9
Isoleucine	52,92	54,81	56,7
Phenylalanine	49,0	50,75	52,5
Threonine	42,84	44,37	45,9
Valine	53,48	55,39	57,3
In all	413,0	427,75	442,5

The comparison of the graph (Fig. 2) content of essential amino acids in the protein milk with dry corn grain are convincing evidence that low lysine content in grain corn proves of necessity in maximum enzymatic cleavage of nutrients and crude protein in the rumen of cows for microbial protein synthesis. When the thermally processed corn arrives in the small intestine of a cow protein is degraded into amino acids to be absorbed into the bloodstream, but protein synthesis milk will be low in lysine levels in it. Because the dry corn at drying in any dryer at feeding of high-performance cows will have less effect than canned wet grain.

Conclusions

New principles of balance of essential amino acids in highly productive cows feeding based on a comparison of the amino acid content of milk proteins and microbial protein with content of these acid in feed ration. The content of essential amino acids in milk proteins are identical their content in microbial protein of rumen and friends such acids in soybean grain. Obtaining the average per day milk yield of 20 liters of milk provided at the expense of microbial protein when balance of the diet by crude protein of bulky and concentrated feed and starch with sugar according the norms of feeding highly productive cows. When fermentation in the rumen high-protein feed at 70% amino acids lysine and methionine are critical for the synthesis of milk. Bulky and concentrated feed cereals is necessary as physiological function for microbial protein synthesis, products of soybean processing, sunflower meal, corn peas and broad beans must be heat-treated to reduce degree of protein cleavage in the rumen to 60% and increase fermentation in the gut. When high performance of cows calculated revenues only lysine and methionine in non-degradable protein mostly high-protein feed that comes from proventriculus in the small intestine for a given level of milk synthesis, as well as other essential amino acids are not critical at high their fermentation in the rumen.

References

1. *Богданов Г. О.* Теорія і практика нормованої годівлі великої рогатої худоби: [Монографія] за ред. В. М. Кандиби, І. І. Ібатулліна, В. І. Костенка. — Житомир: ПП «Рута», 2012. — 860 с.

2. *Богданов Г. О.* Норми, орієнтовні раціони та практичні поради з годівлі великої рогатої худоби: [посібник]; за ред. І. І. Ібатуліна, В. І. Костенка. — Житомир: ПП «Рута», 2013. — 516 с.

3. *Ваттио М. А.* Основные аспекты производства молока. Цикл статей / М. А. Ваттио, В. Т. Ховард / Международный Институт по исследованию и развитию молочного животноводства им. Бабкока. Университет Висконсина, Мэдисон, 2000.

4. *Грудина Н. В.* Повышения эффективности высококонцентрированных белковых кормов путем применения защищающих агентов, снижающих распадаемость протеина в рубце / Н. В. Грудина, В. И. Алексахин, Б. Д. Кальницкий и др. // Доклады РАСХН. — 2005. — № 2. — С. 33-35.

5. *Дурст Л.* Кормление сельскохозяйственных животных / Пер. с нем. А. И. Чигрина, А. А. Дягилева; Под ред. И. И. Ибатуллина, Г. В. Проваторова / Дурст Л., Виттман М. — Винница: Новая книга, 2003. — 382 с.

6. *Калашников А. П.* Нормы и рационы кормления сельскохозяйственных животных: Справочное пособие / Калашников А. П., Клейменов Н. И., Баканов В. Н. и др. — М.: Агропромиздат, 1985. — 352 с.

7. *Калашников А. П.* Нормы и рационы кормления сельскохозяйственных животных: Справочное пособие. 3-е издание / Под ред. А. П. Калашникова, В. И. Фисинина, В. В. Щеглова, Н. И. Клейменова. — М.: Джангар, 2003. — 456 с.

8. *Bach A.* Nitrogen metabolism in the rumen / A. Bach, S. Calsamiglia, M. D. Stern // J. Dairy Sci. — 2005. — Vol. 88. — P. 9-21.

9. *Benchaar C.* Effects of extrusion of whole horse beans on protein digestion and amino acid absorption in dairy cows / C. Benchaar, M. Vernay, C. Bayourthe, R. Moncoulon // J. Dairy Sci. — 1994. — Vol. 77 (5). — P. 1360-71.

10. *Dust J. M.* Extrusion conditions affect chemical composition and in-vitro digestion of selected food ingredients / J. M. Dust, M. A. Gajda, A. E. Flickinger et al. // J. Agri. Food Chem. — 2004. — Vol. 52. — P. 2989-2996.

11. *Orias F.* The effects of dry extrusion temperature of whole soybeans on digestion of protein and amino acids by steers / F. Orias, C. G. Aldrich, J. C. Elizalde

et al. // J. Anim. Sci. — 2002. — Vol. 80. — P. 2493-2501.