



SPECIFICATION OF NORMS OF A PROTEIN FEED OF DAIRY COWS IN THE FIRST PHASE OF A LACTATION

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ABSTRACT

Two experiments on cows were completed to specification of norms of a protein feed for cows in the beginning of a lactation on first -heifers a method of the periods (4x3) and a method of the groups - periods (3x2) on pubertal cows of black-and-white breed in conditions of a vivarium in the first 2 months of a lactation. In all periods of experiment of a cow received hay - silage-concentrates rations. In the first experience, increasing a level of a metabolic protein in a ration on 5,8 and 11,7 %. In the second experience the trial group obtained in structure a ration of a metabolic protein on 16 % and on 9,5 % is more than control group due to different structure of a mixed food. The researches lead by us have shown, that for rising milk yields at cows with a normal fatness before calving and medium a level of milk efficiency on a pique of a lactation up to 30kg milk, production of milk protein in the first phase of a lactation of cows (up to 10 %) is possible for increasing by augmentation of a level of metabolic protein in rations on 10 % till 45-th day of a lactation. Further of cows it is necessary to nurture on existing norms of a metabolizable protein.

KEYWORDS cows, blood, balance, the absorption, substrates, forages, norms.



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INTRODUCTION

Long investigations in the field of cattle breeding promoted its intensification in many countries of the world¹⁻². In modern cattle investigations huge attention is devoted to the questions of youngsters' functional state³ and approaches to the growth of cows' dairy efficiency⁴. It becomes clear that cattle's health and efficiency at any age mostly depend on nourishing feeding and digestive system state⁵⁻⁶. In the experiences which have been lead earlier on high-yield lactating cows, we had been specific necessary levels degradation in rumen and digestibility not degradation protein and estimated as a first approximation substrates structure of metabolizable energy in the first and the subsequent phases of a lactation⁷. Necessity of specification of these parameters is caused by that in the first phase of a lactation (0-90-day), three stages having fixed physiological features are legibly parted. In the first month of a lactation a limiting factor of delivery of an organism nutrients is the becoming of new type of a fermentation in the rumen, amount of consumed starch connected to sharp augmentation. It constrains development of a consumption level of forages and results on 3-4- weeks of a lactation in negative balance of power of an organism, that, in turn, results in risk of originating of ketosises. Besides at cows in the time efficiency of microbial synthesis as while there is a process of augmentation pool microorganisms in rumen and rather smaller amount of microbial cells is evacuated from rumen is reduced also. Approaches existing now to definition of requirement of dairy cows in a metabolic protein⁸ provide the count only alive mass and a level of production of milk protein, thus at calculation of a level of microbial synthesis is not taken into account change of its efficiency in dependence on day of a lactation. On this cause even at strictly standardized feeding of a cow in this period can test deficiency in an exchange protein. As first three months of a lactation differ among themselves with significant changes in a consumption level of forages, a degree of adaptation of a microflora to growing quantity and quality of forages of a ration, production of milk protein, features of metabolic processes and parameters of the hormone status, the correcting of norms of metabolic protein for lactation cows with the count of month of a lactation is required. Overall aim of researches was to specify norms of a metabolic protein for lactation high-yield cows and to develop ways of maintenance of high efficiency at conservation of physiological homeostasis of animals and qualities of milk. The first stage of work was specification of a level of a metabolic protein in the first phase of a lactation, up to achievement of peak of milk efficiency at the optimized structure of metabolizable energy and a metabolizable protein.

MATERIALS AND METHODS

Fulfilled work was made in accordance with ethical principles established by the European convention on vertebrates' protection which are used for experimental and other scientific purposes (adopted in Strasbourg 18.03.1986 and ratified in Strasbourg 15.06.2006). The

work was approved by ethic Committee of the all-Russian scientific research Institute of physiology, biochemistry and nutrition, Borovsk (Kaluga region, Russia) (Protocol №5 from 12.05.2015).

Experimental design, feeding and management of cow

For the decision of tasks in view two experiences on cows black-and-white breed in conditions of vivarium have been carried out. The first experience carried out a method of the periods on 4 cows - first heifers in alive mass 420kg from 15-th lactation till 65-th day. In the first period (15-30 day) rations of cows have been optimized on structure of metabolizable energy and a metabolic protein, agrees the norms of a feeding developed by us⁷. In the second periods of experience (30-45 days) in rations of cows increased the content of a metabolic protein by 5.8%, and in the third periods (45-65 days) - on 11.7 % due to padding inclusion in structure of a ration of the concentrated proteinaceous additive with the content of an available protein for mastering 85 % (tab. 1). In all periods of experiment of a cow obtained a ration from keeping 50-60% of concentrated foods on nutritiousness. A feeding of cows - double at 8.00 and 18.00. The second experience is carried out by a method of the groups - periods on eight cows (the second - third lactation, alive mass 473kr, a daily average milk yield 25kr milk), on four heads in group. In 1-st period of 2-nd experience (with 10-35- day of a lactation) cows of 1-st and 2-nd groups obtained the mixed foods of different structure providing a different level degradation and nondegradation of a protein, and also starch (tab. 2). The ration has been designed for reception 25kr milk and has consisten of a silage vetch-oat, hay of grasses, beet molasses and mixed foods. On this background 1-st group of cows received a ration providing degradation a protein efficiency of microbial synthesis at a level 24g microbial nitrogen on kg digestive organic matter (DOM) thus the estimated contribution of a glucose to structure of metabolizable energy was up to standard of 10 %. In 2-nd group the quantity degradation a protein was standardized on more substantial efficiency 20g nitrogen on kg DOM, and the estimated level of a glucose in structure of metabolizable energy compounded 12%, due to the greater lobe of corn in a mixed food. The technique of an evaluation substrates structure of metabolizable energy is described before. The normative data on degradation and digestibility to starch are given in work⁷. In 2-nd period of 2-nd experience (from 35-th lactation till 65-th day) estimated consumption of metabolic protein at cows of 1-st group corresponded to a level of milk efficiency (100% of security, basically due to a sunflower and soya oil-seed meal). In 2-nd group in a ration the content of metabolic protein was higher 9,5%, at the same level of metabolizable energy. Thus the estimated lobe of a glucose in metabolizable energy also was higher 7,5 %.

Measurements and sampling⁹

At the end of each period in both experiences carried out balance measurements for the count of consumption of a forage, secretions urine, a faecal matter, and also determined a diurnal gas exchange, weighed animals, defined digestibility nutrients, parameters of

microbiological processes in rumen. Samples of a rumen liquid obtained before and after a feeding with the help esophagus a probe, an exchange of nitrogen and power, also absorption of metabolites of blood by a mammary gland and chemical composition of milk. During experiences led the daily count of amount of the consumed forages, defined chemical structure of forages of a ration. Cows weighed during experiences once in 30 days. Samples of blood of a carotid artery and mammary vein took a puncture of vessels up to a feeding, in 3 hours and through 8 after a morning feeding; serum was preserved at -20°C until analysis.

Chemical analysis

The chemical composition of feeds and refusals was analysed according to⁹ methods (Kalnitsky BD.). Milk composition was determined using a Milko-tester F3140(Foss Electric, Denmark). The fatty acid profile in milk was determined by the same gas chromatography apparatus (Colour - 800). parameters of microbiological processes in rumen (pH, VFA and their ratio on a gas chromatograph after apparatus Martgama, ammonia diffusive method Convey, number of bacteria and protozoa, amyolytic and cellulolytic activity)⁷. Defined an arteriovenous difference of concentration of metabolites on a mammary gland and efficiency of their absorption (a glucose (oxidase procedure), volatile fatty acids (VFA) (on a gas chromatograph Colour - 800), ketone bodies, nonesterified fatty acids (NEFA), triacylglycerols - by means of enzymatic colorimetric method (the panel of reagents of firm « Soared Diagnostic SPb »), loose amino acids (on aminoacid analyzer AAA-T339), a urea was determined colorimetrically by an automated diacetylmonoxime method⁹⁻¹⁰. A blood-groove through a mammary gland estimated in the settlement way on attitudes of an output with milk of thyrosinum and phenylalanine to their arteriovenous difference¹¹. Absorption of substrates determined multiplication of average value of an arteriovenous difference to a blood-groove. Efficiency of utilization of metabolizable energy on synthesis of components of milk estimated under the attitude of integral power of the substrates absorbed by a mammary gland, to power output with milk, and also under the attitude of power, discharged with milk to productive metabolizable energy (metabolizable energy - expenses for maintenance). Efficiency of utilization of a protein of a forage estimated under the attitude of output milk protein to consumed, either digested, or to the acquired protein. Magnitude of metabolizable energy, digestible and the absorption protein determined in balance experiences. The statistical processing of the data was done in the SPSS for Windows 11.5 computer programme. The differences between treatments were then estimated using the LSM method. $P < 0.05$ was considered significant.

RESULTS AND DISCUSSION

In 1-st experience to basic diet added growing amounts of concentrated proteinaceous additive Soyprot with the content of a protein of 51 % and availability, fixed us at a level of 63,3 %, instead of specified-85 %. Degradation in

rumen the joint venture of the given additive was at a level of 13 %. Results of experiences have shown, that at augmentation of norm of metabolic protein the tendency to augmentation of milk efficiency on 2,2 and 6,1 %, protein milk on 1,7 and 7,5 % and an output of protein with milk on 4,1 and 11,4 % was observed, at degrees of production of fat of milk on 7,8 and 4,8 %. Results of balance experiences and studying enzymatic and microbiological processes in rumen have shown, that the feeding of the proteinaceous additive did not affect on processes of digestion (the data are not given). It is possible to believe, that in 2-nd trial period padding entering of amino acids from a digestive tract in the greater degree was used on restoration of proteinaceous reserves of a body, that proves to be true the data on adjournment of nitrogen in a body-14,6 - 21,1g/day - in comparison with 1-st period of experience ($p < 0,05$) (tab. 3). At the further augmentation of entering of amino acids there was a redistribution of a torrent on synthesis of proteins of milk, and adjournment of nitrogen remained at a level of control group (10,4g/day). Hence, the padding quantity of aspirated amino acids first of all is referred on restoration of stores of proteins of a body and only then (in 2 weeks) on synthesis of milk protein. Utilization of nitrogen on adjournment and education of proteins of milk at augmentation of norm of a metabolic protein at 5,8 % was characterized by efficiency at a level of control group. At the further rising a level of entering of protein efficiency of its utilization on production sharply drops. In these conditions percentage secretion of nitrogen with a urine both from accepted, and from digested increased. efficiency of utilization of nitrogen on milk practically did not variate (51,1; 48,1 and 48,5 % from digested), but his mastering in percentage terms (58,8 sharply dropped; 58,7 and 53,3 %) ($p < 0,05$) from digested. Thus as in blood (the level of a urea grew by 8,1 %) ($p < 0,05$), and in milk (16,7 %) ($p < 0,05$). These data testify to excess of entering of a metabolic protein in 3-rd season of experience. Rising of norms of the metabolic protein, resulting in is typical, that to augmentation of secretion of protein with milk, was accompanied by downstroke of thermostability of milk (1 category, 2,5 and 3,25) ($p < 0,05$). Efficiency factors of utilization of metabolizable energy (ME) on milk production in all seasons of experience were practically identical and compounded 46,2; 44,2 and 45,8 %. Padding entering of protein was not invoked in first heifers of rising of mobilization with a fat depo, and the negative balance of power was stored at a level 7MJ (the data are not given). In these experiences drop of fatness of milk (4,27±0,10 was observed; 3,85±0,14; 3,83±0,11) and the common secretion 844,6; 778; 804,3r, that, apparently, is connected to drop of absorption by a mammary gland of an acetate (on 17-35 %) ($p < 0,05$) and not compensated augmentation of absorption triglyceride and NEFA (the data are not given). Thus, the obtained data testify, that for rising production of milk protein in the first phase of a lactation at first heifers it is possible to increase existing norms of metabolic protein by 10 %, but in these conditions efficiency of utilization of protein on the productive purposes drops. In connection with limitation the fat depo at cows - first heifers was observed drop of fatness of milk and his secretion with milk on 10 % in the

given conditions of experience. In 1-st period of 2-nd experience, (from 15-th lactation till 35-th day) rising of a level of a metabolic protein in a ration on 16 % in comparison with 1-st group was reached due to a different level degradation and nondegradation a protein in rations. Thus it was supposed, that rising of a milk yield will be accompanied by higher rates of mobilization a fat depo, therefore in structure of metabolizable energy improved a lobe of a glucose, due to a variation of levels degradation and digestion starch. In the given nutritional conditions the different structure of a mixed food result ined to the a little bit greater consumption of roughages in trial group within the first month of a lactation, however these differences were not statistically authentic. Both daily average parameters of a fermentation in rumen, and dynamics of their changes had no authentic intergroup differences. The tendency of level recession of ammonia in rumen of cows of trial group that is connected to a dropped level degradation a protein in a ration in comparison with control 1-st group ($12,95 \pm 0,95$ and $11,95 \pm 0,17$ mg % is marked; $p > 0,05$). At the same time at animals of this group it is not fixed changes in level VFA, that is connected to the big consumption (on 10,3 %) and digestion of fractions of cellulose (on 18,1%). Daily average parameters cellulolytic activity in rumen were authentically above at cows of trial group ($14,2 \pm 1,30$ and $21,0 \pm 1,06$; $p < 0,05$), that, apparently is connected to more even fermentation of carbohydrates in rumen. So in three hours after a morning feeding in rumen of cows of trial group low level VFA ($8,3 \pm 0,16$ - $10,2 \pm 0,54$ mM/dL is marked more; $p = 0,075$) in comparison with control group. Digestion all nutrients in a gastrointestinal tract of cows of trial group was higher, and for a protein ($64,8 \pm 0,87$ and $68,8 \pm 0,54$; $p < 0,05$), leaches ($14,0 \pm 4,8$ and $28,9 \pm 6,2$; $p < 0,05$) and fat ($65,2 \pm 2,6$ and $70,2 \pm 0,2$; $p < 0,05$), $46,7 \pm 8,6$ and $51,2 \pm 4,9$; $p < 0,1$), cellulose ($65,8 \pm 4,2$ and $69,8 \pm 7,9$; $p < 0,1$) it is statistically authentic. Measurements of nitrogen balance in an organism of cows has shown, that at augmentation in a ration of the content of an available protein for mastering on 9,5 % in comparison with norms, secretion of nitrogen with a faecal matter and a urine first of all dropped, as has determined the greater secretion of nitrogen with milk (tab. 4). At augmentation of norm of metabolic protein efficiency of utilization of accepted and digested nitrogen on a milk manufacture at cows of trial group was authentically above (tab. 4). Efficiency of utilization of a metabolic protein designed with the count of expenses of a protein on function of maintenance has made in control group of 67,9 %, and in trial 71,1 % that is connected to the best equation of a metabolic protein on essential amino acids in trial group (the settlement data)¹². Rising of a level of utilization of the nitrous forms on education of milk at cows of trial group, in our opinion, is connected to downstroke of an absorption of ammonia to what downstroke of its concentration in a rumen liquid and downstroke of secretion of nitrogen with a urine obliquely testifies. Thus concentration of a urea in blood of animals of trial and control groups (tab. 5) practically did not differ. On concentration in blood of the basic precursors of milk (tab. 5) of authentic differences between groups it is not revealed. At the same time absorption amino nitrogen in a

mammary gland has increased for 22,4%, a glucose on 45%, triacylglycerols on 60,9%. The augmentation of absorption descended as due to augmentation of efficiency of extraction (for a glucose and an acetate), and due to intensifying the mammary blood flow on 42,4%. Parameters of balance of power at cows testify, that as well as it was supposed, the augmentation of a milk yield and energy release descended to milk due to intensifying mobilization from a fat depo to what the greater parameter of negative balance at cows of trial group testifies, and the big loss alive masses (tab. 6). Results of this experience have shown, that at augmentation of norm of a metabolic protein at 16 % rising milk efficiency on 30,8 %, fatness of milk on 11 % and an output of protein with milk on 26 %, and fat on 43,9 % ($p < 0,05$) was observed. The data obtained by us have confirmed opinion on smaller efficiency of microbial synthesis of protein in rumen of cows in the first month of a lactation and necessity of augmentation of a lobe nondegradation a protein in this season, in the common level of a protein¹³. In 2-nd period of 2-nd experience in rations of cows of trial group the content of a metabolic protein was higher, than in control group on 9,5 %. As against the content of forages and nutrients in rations which practically did not differ, actual consumption of forages and nutrients cows of trial group was much higher (12,5 %; $p < 0,05$), basically due to the greater consumption of roughages. The common consumption of dry matter on 100kg alive mass for 60-th day of a lactation has made 4kg, that is a maximum level of consumption, is especial for the given month of a lactation. The amount of digested nutrients in a gastrointestinal tract of cows was for the benefit of trial group, due to their greater consumption since переваримость all nutrients in both groups practically did not differ. The amount faecal N and urinary excretion in both groups as did not differ, and secretion of nitrogen with milk in trial group was higher due to the greater adjournment of nitrogen at cows of control group (tab. 4). On seen, cows of control group for the account of less intensive раздоя had redistribution of torrents of absorbed substrates on adjournment in a body in comparison with trial animals earlier. For the benefit of it more efficient and authentic utilization of nitrogen on education of milk at cows of trial group and practically identical efficiency of its common utilization (on milk and adjournment) (tab. 4) testifies. The balance of power for 60-th day of a lactation in both groups was positive, that testifies to prospective early fading a dominance of a lactation at cows with the given efficiency (tab. 6). However absolute values of adjournment of power at крпоров in 2 times were lower than trial group, that testifies to an effective utilization of metabolic and productive power on milk at cows of trial group (is higher than at cows of control group 16,8 and 20 % ($p < 0,05$)). According to measurement of concentration of precursors of milk in blood inflowing and flowing off from a mammary gland, an arteriovenous difference and efficiency of absorption it fixed, that higher milk yield at cows of trial group was provided basically for the account of more intensive the mammary blood flow and only in part - for the account of more efficient extraction of amino acids, a glucose, an acetate and triacylglycerols (tab. 5).

Table 1
Rations of a feeding of cows on the periods of experience (1-st experience)

Feeds	Ед. изм.	Periods of experiments		
		1-st	2-st	3-st
Hay grasses	kg	3	3	3
Silage grasses	kg	20	20	20
Concentrates	kg	8	8	8
Feed additive «Soyprot» (Shouten Products B. V. Holland)	g	0	150*	300*
In a ration contained:				
Metabolizable energy	MJ	135,1	136,6	138,1
Dry matter	kg	15,7	15,83	15,83
Crude protein, in, в т.ч.:	g	1971	2048	2124*
degradation protein	g	1123	1133	1143
Nondegradation protein	g	848	915	981
Crude fiber	g	3525	3528	3535
NDF	g	6820	6825	6839
Starch	g	4397	4433	4481
Sugar	g	505	508	512
Lipids	g	410	412	416

The note: *- p<0.05 in comparison with the first period

Table 2
Rations of a feeding of cows on the periods of experience (2-nd experience)

Feeds	1-st group		2-nd group	
	1 period	2 period	1 period	2 period
Hay grasses, kg	4	4	4	4
Silage vetch-oat, kg	21	21	21	21
Beet molasses, kg	1	0,8	1	0,8
Concentrates, kg	9	9	9	9,75
In a ration contained:				
Metabolizable energy, MJ	166,8	189,6	165,2	197,0*
Dry matter, g	17928	20470*	17874	20470*
Crude protein, g	2662	3131*	2731	3141,8*
degradation a protein, g	1599	1819*	1504	1775*
Nondegradation a protein, g	1062	1311*	1226	1365*
Metabolic protein, g	1429	1611	1494	1765*
Crude fat, g	393	521*	411	558
NDF, g	6609	8067	6607	8100*
Starch+ sugar, g	6901	6775	6733	6806
Degradation starch, g	2318	2195	2092	2584*
Nondegradation-digestion starch, g	686	680	797	731
Crude fiber, g	3443	4541*	3186	4632*

The note: *- p<0.05 in comparison with the first period

Table 3
Utilization of nitrogen in an organism of cows

Parameters	The periods of experience		
	1-st	2-nd	3-rd
N intake, g/d	312,8	326,3	341,0*
faecal N excretion, g/d	123,3	126,8	123,6
urinary N excretion, g/d	78,0	82,4	101,5*
milk N excretion, g/d	96,8	96,1	105,5*
N retention, g/d	14,6	21,1*	10,4
milk N excretion, % N intake	30,9	29,5	30,9
milk N excretion, % N absorbed	51,4	48,4	48,7
assimilated N, % N intake	35,6	35,8	33,8
assimilated N, % N absorbed	58,8	58,6	53,3*

The note: *- p<0.05 in comparison with the first period

Table 4
Utilization of nitrogen in an organism of cows in of 2-nd experience

Parameters	Groups of animals			
	I period		II period	
	1-n	2-n	1-n	2-n
N intake, g/d	401,0	417,4*	458,7	484,5
faecal N excretion, g/d	141,6	135,6	160,9	165,9
urinary N excretion, g/d	162,6	155,8	161,8	171,6
milk N excretion, g/d	103,1	130,5*	105,1	125,3
N retention, g/d	-0,11	-4,5	30,9	21,6
milk N excretion, % N intake	25,6	31,2*	22,8	25,8*
milk N excretion, % N absorbed	38,6	46,5*	35,1	39,2*
Assimilated N, % N intake	25,5	29,9	29,5	27,2
Assimilated N, % N absorbed	38,4	44,3	45,4	41,7

The note: *- p<0.05 in comparison with the first period

Table 5
The daily average content in blood of a jugular vein of cows of the basic precursors of milk in of 2-nd experience

Parameters	Groups of animals			
	I period		II period	
	1-n	2-n	1-n	2-n
α-amino nitrogen, mg /dL	4,46	4,06*	4,62	4,42*
Glucose, mM/dL	2,94	3,03	2,76	2,99*
Triacylglycerols, mg /dL	10,08	11,31	9,15	9,07
Urea, mmol /L	2,87	3,0	2,8	2,85
VFA, mM/L	1,23	1,27	1,23	1,3
Acetate, mM/L	1,09	1,13	1,08	1,139
Propionate, mM/L	0,11	0,122	0,14	0,147
Butyrate, mM/L	0,025	0,025	0,013	0,014
The common lipids, mg/dL	308,1	296,2	323,2	369,4*

The note: *- p<0.05 in comparison with the first period

Table 6
Balance of energy at cows in of 2-nd experience, MJ/day

Parameters	Groups of cows			
	I period		II period	
	1-n	2-n	1-n	2-n
Gross energy of a forage	287,9	295,4	315,7	333,1*
Digestible energy	185,0	191,3	210,5	222,7*
Energy loss with methane and heat of a fermentation	30,9	31,1	35,2	36,1
Milk energy	59,6	76,0*	60,3	74,8*
Energy in urine	9,97	8,21*	9,03	9,4
Metabolisable energy	144,1	152,0*	166,3	177,1
Heat production	92,5	93,4	93,5	96,0
Energy retention	-8,02	-17,3	12,35	6,3*
energy utilization for milk production, %	41,0	49,8*	36,1	42,2*

The note: *- p<0.05 in comparison with the first period

CONCLUSION

It's acknowledged that many physiological characteristics of an organism are defined by inheritance¹⁴⁻¹⁶, habitat conditions¹⁷⁻¹⁹ and feeding peculiarities²⁰⁻²². Statement of a problem of the given research is caused by absence in existing systems of a setting of a feed of cows of the differentiated evaluation of requirement for a metabolic protein on months of a lactation that does not allow to use efficiently protein of a forage and to provide requirements of dairy cows for amino acids on manufacture of milk protein. The researches carried out by us have shown, that for rising milk yields at cows with a normal fatness before calving and medium a level of milk efficiency on a pique of a lactation up to 30kg milk, production of milk protein in the first phase of a lactation of cows (up to 10 %) is possible for increasing by augmentation of a level of

metabolic protein in rations by 10 % till 45-th day of a lactation. Further of cows it is necessary to foster on existing norms of a metabolic protein. Thus up to 45 days of a lactation in connection with enlarged rates of mobilization a fat depo, it is necessary to provide in a ration a sufficient level nondegradation starch (up to 800g). In connection with limitation a fat depo at cows - first heifers this method should be applied, if it is possible to provide deficiency of metabolizable energy in first two months of the lactation, resulting in to loss no more 600g/day.

CONFLICT OF INTEREST

Conflict of Interest declared none.

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