# Protein Requirement of Pregnant Yakut Mares

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**Abstract.** Inclusion of feed additives in the winter diet of pregnant mares increases the consumption of crude protein on 3-21%, for digestible 4-32%. In the summer experience, when grazing on alas and valley meadows Yakut mares consume an average of 330 g per day of crude protein per day on 100 kg live weight 211 g of digestible protein. This is according to 5 experiments. In winter, the consumption of crude protein was at 209 g per day per 100 kg live weight on digestible protein, 136 g for an average of four experiments with data on natural herbage of winter pasture. During summer, the horses' body is intense accumulation of reserve elements, increasing fatness, first by increasing muscle mass, further due to the deposition of subcutaneous fat and visceral fat in the abdomen. At this time in our experiments mare consumed 330 g per day on 100 kg live weight.
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## 1. Introduction

Energy deficit in feed is the main cause of low reproduction in horse breeding. Another limiting factor is the availability of the protein. A base for full protein nutrition of horses is to provide a specific set of amino acids for animals. Traditional hay-oat diets unbalanced for essential amino acids - lysine and methionine, the lack of which is 30-40% of the standards. Value is determined by amino acids that they can be used to increase the usefulness of protein feed, and thereby, reduce the consumption of the production process. This particularly applies to lysine - the first limiting amino acid for horses, which can reduce the enrichment of protein nutrition standards by 15-20% [3] (R. Bichon, 2004). Lysine is a part of all proteins and is essential for the formation of the skeleton (promotes the absorption of calcium and phosphorus) and increase of milk production. Affects the energy and lipid metabolism, determines the activity of some enzymes, red blood cells and the nervous system, ensure the normal flow of the vital processes of cells. Deamination of lysine is an irreversible process, it is important that it is continuously fed into the body during digestion. Lysine deficiency in the body leads to muscular dystrophy, stunted growth, disruption of the sexual cycle in females. Methionine promotes the growth of body and hair, a methyl group donor for the synthesis of choline and keratin. And also prevents oxidation of proteins, prevents fatty liver, neutralizes toxic substances in the liver, is involved in the formation of hemoglobin. Symptoms of failure are the coarsening of hair, muscle atrophy, anemia [8] (T.J. Kuhn, 1983).

The article discusses the experimental materials on the needs of Yakut horses in protein.

## 2. Materials and Methods

Scientific and economic experiments conducted in Experimental Enterprise "Krasnaya Zvezda" in Megino-Kangalassky ulus for pregnant mares of Yakut breed in February and March.

Mares in each experiment were divided into two groups, by analogy - the control and experimental with 10 heads in each group. Animals during the experiments were placed in special paddocks. Duration of the experiment - 45 days.

Terms of keeping and feeding groups were identical. Experiments were carried out according to the scheme in Table 1, at the end of the experiments it was conducted definition of nutrient digestibility. The account of given fodder was held daily, feeding of the animals - twice: in the morning and evening. Feed ration was of good quality, the animals ate them willingly and almost completely.

Accounting period in the experiment on digestibility lasted 6 days according to the procedure of [13] A.I. Ovsyannikova (1976).

Mares of I experimental group received basal diet with replacement of 1 kg of oats - feed additive consisting of local raw materials, which includes willow flour, wheat germ, brewer's grain, Kempendyai salt and probiotic "Sakhabaktisubtil". For mares of II experimental group oats was replaced with 1 kg of feed additive.

Table 1. Scheme of scientific and economic experiments

| Group | Number of Heads | Features of Feeding | in a Group |
|---|---|---|---|
| | First Experience | | |
| Control | 10 | Hay - 10 kg, oats - 1 kg, | Kempendyai salt - 30 g |
| Experimental | 10 | Hay - 10 kg, +recipe #4 + probiotic feed additive "Sakhabaktisubtil" | Kempendyai salt - 30 g |
| | Second Experience | | |
| Control | 10 | Hay - 10 kg, oats - 1 kg, | Kempendyai salt - 30 g |
| Experimental | 10 | Hay - 10 kg, + recipe #5 of the feed Additive | Kempendyai salt - 30 g |

**3. Results and discussion.**

The defining problem in winter preventive feeding and stationary short feeding of Yakut pregnant mares is the poor quality of basic fodder - hay of natural lands (Table 2). Because of the high fiber content (up to 35% of dry matter) energy contained in the cell wall, difficult to digest, and is unable to meet the full needs of the organism [12] (P.F. Permyakova, etc.).

Table 2. Chemical composition of the diet used in the feeding of pregnant mares

| Index | In absolutely dry matter, % | | | | | |
|---|---|---|---|---|---|---|
| | protein | fat | fiber | ash | NFE | |
| Hay* | 7.26 ±1,14 | 2.96±005 | 35.87±0.47 | 5.20±0.12 | 45.63 ±0.91 | |
| Oats* | 20.43 ±0.35 | 2.95 ±0.22 | 14.06 ±0.11 | 2.87 ±0.05 | 51.94 ±0.44 | |
| g/kg | | | | | | |
| | Ca | P | K | Mn | Na | Cl |
| Hay* | 6.4 ±0.04 | 2.4 ±0.01 | 11.61±0.12 | 5.02 ±0.08 | 2.10 ±0.02 | 4.01 ±0.01 |
| Oats* | 0.25±0.01 | 3.1 ±0.01 | - - | - - | | |

Note: Average general sample for all groups*.
NFE – nitrogen-free extractives.

Recipes are for pregnant mares in Table 3.

According to researches of M.F. Gabyshev, A.A. Kazansky, A.D. Egorov green leaves of big scaly chosenia contain 32.14% of protein, 4.25-6.61% fat, fiber 7.0-14.0%, 5.46-7.33% calcium 0.38-0.57 % phosphorus. Gmelin's willow that grows in the islands of the Lena River, contains in the month of July: moisture - 60% protein - 9.2, fat - 3.3, fiber - 20.4, ash - 5.8, carotene - 46.0 mg/kg, and in winter - 53.1%, 3.2, 1.5, 22.6, 2.0, 1.0 respectively. Their mineral composition: calcium - 1.65%, phosphorus - 0.65%, sodium - 0.64 g/kg, potassium - 12.5 g/kg, iron - 230.0 mg/kg, magnesium - 30.0 mg/kg, copper - 5.9 mg/kg; composition varies in winter: calcium - 0.70%, phosphorus - 0.08%, sodium - 0.06 g/kg, potassium - 6.0 g/kg, magnesium - 33.0 mg/kg, copper - 5,3 mg/kg [15] (N.T. Popov, etc., 1977).

Table 3. Recipes of feed supplement for pregnant mares

| Components | Units of Measure | Recipe #1 |
|---|---|---|
| Brewer's grain | g | 210 |
| Talnikova flour | g | 220 |
| Germinated wheat | g | 540 |
| Kempendyai salt | g | 30 |
| Probiotic "Sakhabaktisubtil" | ml | 20 ml per 5 billion CFU/ml |
| Components | Units of Measure | Recipe #2 |
| Brewer's grain | g | 210 |
| Zeolite | g | 220 |
| Germinated barley | g | 540 |
| Kempendyai salt | g | 30 |

Talnikova flour is eaten very well and is a source of minerals.

Germinated wheat in the feed additive was included as an energy-protein supplement as a source of vitamins.

[2] G.P. Belehov, etc. (1965) writes that germinated grain is used for winter feeding of animals for enriching diets with vitamins. If the grain germinated for 6-8 days, the green sprouts reached 6.8 cm, and in this case they accumulate vitamin C and carotene. When the grain germinated for 2-3 days before the white sprouts grow carotene content increases by 24 times and vitamins B2 - in 6-8 times in comparison with non-sprouted grains.

In studies of [7] O.A. Kosharov (2007) on improving the technology of horses' reproduction was found that supplementation for the diet for mares of Russian horse breed with dry malt sprouts and fresh sprouted barley, have positive impact on the safety of pregnancy, resulting in higher yield of foals at 20 and 10%, respectively.

[3] R. Bishop (2004) relates feed yeast to stimulants of digestion. In the diet of horses, writes R. Bishop, yeast stimulate bacterial fermentation in the large intestine, thereby improving digestion of fiber. In addition, yeast is a source of protein and B vitamins.

We have included the brewer's grain in feed additive to stimulate the eatability of the diet and improve the digestibility of fiber. We believe that in the quantities that we used it in the diet (210 g per day per head in the mixture); brewer's grain should not cause indigestion, bloating and constipation leading to abortion.

The composition of the feed additive recipe #1 is also included preparation "Sakhabaktisubtil" [16] (S.S. Tatarinova, etc, 2009), created in a laboratory of microbial preparations in the Yakut Scientific Research Institute of Agriculture based on strains of bacteria Bacillus subtilis TNP-3 and Bacillus subtilis TNP-5 isolated from permafrost soils of Yakutia and certified in the Russian Collection of Microorganisms Used in Animal Husbandry and The All-Russian State Center for Quality and Standartization of Veterinary Drugs and Feed (VGNKI).

The strains have a pronounced antagonistic action against pathogenic and conditionally pathogenic microorganisms (bacteria, fungi and viruses); interferon activity; immunostimulating effect; an ability to produce enzymes and stimulate the growth and development of beneficial intestinal microflora.

Considering the fact that mares' active fetal growth begins in the last 3 months (90 days) of pregnancy and fetal weight is 10% of the live weight of the mare, the need of the exchange energy in the mare at this time is about 106.0 MJ [11] (P.F. Permyakova, etc. 2011; [5] R.V. Ivanov, etc. 2013). Metabolizable energy content of the diet, prepared by us [15] (R.V. Ivanov, etc. 2014), corresponds to the needs of the Yakut mares in energy (Table 4).

The dry matter content, crude protein, crude fat, crude fiber, nitrogen-free extractives, macro-and micronutrients and vitamins were within the standards of feeding pregnant mares. At a rate of feeding pregnant mares (live weight of 400 - 600 kg) requires 10.0 - 15.0 kg of dry matter per head per day 1 [10] (Standards and Rations..., 2003).

In both experiments pregnant mares in all groups consumed the same amount of dry substance (10.28 and 10.29 kg, 10.43 kg and 10.16 kg, respectively), which corresponds to normal.

Table 4. Feeding diets of Yakut pregnant mares (1 head per day)

| Index | I experience | | II experience | |
|---|---|---|---|---|
| | control | experimental | control | experimental |
| | Dry Matter Consumed: | | | |
| Hay, kg | 10 | 10 | 10 | 10.0 |
| Oat, kg | 1.0 | - | 1.0 | - |
| Feed Additive, kg | - | 1.0 | - | 1.0 |
| The Diets Contained: | | | | |
| Metabolizable Energy, MJ | 96.3 | 102.6 | 98.13 | 125.54 |
| Dry Matter, kg | 10.28 | 10.29 | 10.43 | 10.16 |
| Crude Protein, g | 1000 | 1030 | 881 | 1068 |
| Calcium, g | 107.4 | 109.5 | 86.47 | 90.71 |
| Phosphorus, g | 18.5 | 22.1 | 24.69 | 31.6 |
| Magnesium, g | 89.0 | 88.8 | 230.61 | 275.29 |
| Copper, mg | 71 | 109.5 | 69.96 | 81.59 |
| Zinc, mg | 269.0 | 22.1 | 260.5 | 323.34 |
| Cobalt mg | 5.0 | 7.7 | 4.64 | 7.13 |
| Manganese, mg | 260.0 | 309.4 | 85.26 | 86.58 |
| Iodine, mg | 3.25 | 4.15 | 2.78 | 3.74 |
| Carotene, mg | - | 1.05 | - | 0.92 |
| Vitamin E, mg | 675.4 | 716.09 | 618.35 | 704.31 |
| $B_1$, mg | 25.0 | 31.6 | 21.06 | 26.92 |
| $B_2$, mg | 128.0 | 130.0 | 103.06 | 105.44 |
| $B_3$, mg | 250.5 | 261.71 | 193.28 | 207.72 |
| $B_4$, mg | 846 | 843.0 | 617.95 | 625.67 |
| $B_5$, mg | - | - | 206.21 | 252.59 |
| $B_6$, mg | - | - | 136.62 | 144.34 |

To study the effect of feed additives on nutrient digestibility of diets it was conducted physiological experiments on six pregnant mares (three mares from each group) at the end of both experiments on feeding. Table 5 shows the nutrient content of the feed eaten.

Table 5. The content of nutrients in the feed eaten and digestibility coefficients in experiments on pregnant mares

| Index | I experience | | II experience | |
|---|---|---|---|---|
| | control | experimental | control | experimental |
| Consumed, g | | | | |
| Dry Matter | 10280 ±0.19 | 10290 ±0.21 | 10.43 ±0.01 | 10,16 ±0.30 |
| Organic Matter | 8900 ±0.01 | 9020 ±0.05 | 8977 ±0.02 | 10314 ±0.27 |
| Crude Protein | 1000 ±0.04 | 1030 ±0.04 | 881 ±0.02 | 1068 ±0.20 |
| Crude Fiber | 3430 ±0.12 | 3420 ±0.02 | 3461 ±0.01 | 3620 ±0.30 |
| Crude Fat | 180 ±0.07 | 180 ±0.04 | 184 ±0.03 | 250 ±0,19 |
| NFE | 4290 ±0.06 | 4390 ±0.23 | 4451 ±0.02 | 5376 ±0.17 |
| Digested, g: | | | | |
| Dry Matter | 6439 ±0.02 | 6970 ±0.46 | 5984 ±0.02 | 7584 ±0.29 |
| Organic Matter | 5839 ±0.02 | 6130 ±0.05 | 5890 ±0.01 | 7302 ±0.03 |
| Crude Protein | 700 ±0.01 | 730 ±0.02 | 392 ±0.01 | 634 ±0.05 |
| Crude Fiber | 1800 ±0.01 | 1930 ±0.23 | 1816 ±0,01 | 2211 ±0.10 |
| Crude Fat | 110 ±0.01 | 120 ±0.01 | 118 ±0.03 | 182 ±0.003 |
| NFE | 3230 ±0.01 | 3350 ±0.07 | 3596 ±0.005 | 4392 ±0.16 |
| Digestibility Coefficient, % | | | | |
| Dry Matter | 62.64 ±0.19 | 67.73 ±0.17 | 62.49 ±0.19 | 68.71 ±0.49 |
| Organic Matter | 65.61 ±0.01 | 67.96 ±0.03 | 56.61 ±0.01 | 70.8 ±0.01 |
| Crude Protein | 70.00 ±0.5 | 70.87 ±0.69 | 54.5 ±0.5 | 59.36 ±0.03 |
| Crude Fiber | 52.48 ±0.29 | 56.43 ±0.27 | 52.47 ±0.29 | 61.08 ±0.28 |
| Crude Fat | 61.11 ±0.53 | 66.66 ±0.74 | 64.0 ±0.03 | 72.8 ±0.02 |
| NFE | 75.29 ±0.20 | 76.31 ±0.60 | 80.8 ±0.20 | 81.7 ±0.15 |

These data indicate that the I experimental group of animals is digested more solids for 531 g (8.25%), and organic matter - 291 g (4.98%), crude protein - 30 g (4.28%), of crude cellulose - 130 g (7.22%), crude fat - 10 g (9.09%) and NFE - 120 g (3.71%) than the control group of animals. The mares of experimental groups digestibility of dry matter is more than 5.1%, organic matter - 2.35, crude protein - 0.87, crude fiber - 3.95, crude fat - 5.55% and NFE - on 1.02% compared to the control group.

Mares in the control group of the second experiment with the same dry matter content of the diet (by 10.43 and 10.16) consumed 98.13 MJ of metabolizable energy, and the animals of the experimental group at 125.4 MJ per day per head, the difference is 27.1 MJ or 27.7% more.

Table 6 gives the performance of the protein value of diets with the inclusion of feed additives used in stationary feeding of pregnant mares before accouchement.

Table 6. Protein Value of the Diet of Pregnant Mares and Their Provision of Digestible Protein

| Forage | Dry matter consumption, kg | Crude protein consumption, g | | Digestible protein content in feed consumption, g | | |
|---|---|---|---|---|---|---|
| | | On one head per day, g | On 100 kg of live weight, g | On one head per day, g | On 100 kg of live weight, g | 1 kg of dry substance, g |
| First experience | | | | | | |
| Control group: Oats+hay | 10.28 | 1000 | 250 | 700 | 175 | 68 |
| Experimental group: Hay + feed additive (Talnikova flour, brewer's grain, sprouted wheat, probiotic) | 10.29 | 1030 | 257 | 730 | 182.5 | 71 |
| Second experience | | | | | | |
| Control group: Hay+oats | 10.43 | 881 | 220 | 480 | 120 | 46 |
| Experimental group: Hay + feed additive (zeolite, brewer's grain, sprouted barley) | 10.16 | 1068 | 267 | 634 | 158 | 62.4 |

The table shows that the inclusion of feed additives increases the consumption of crude protein on 3-21%, 4-32% for digestible.

Previously A.F. Abramov developed standards of feeding for Yakut horses with the needs of digestible nutrients based on an analysis of published data held not in conditions of Yakutia and other breeds of horses. Need for digestible protein for pregnant mares in the second period of pregnancy was determined to be 200 g per day per 100 kg of live weight [1] (A.F. Abramov, 2000).

Feeding norms for pregnant mares (9 months of pregnancy head/day) riding and racing breed with a body weight up to 400 kg on wet protein - 1.0 kg, 0.70 kg of digestible protein, or 100 kg of live weight, respectively - 205 and 175 g per day [10] (Standards and rations..., 2003).

The data of our experiments are below the standards proposed by A.F. Abramov by control groups with oat and hay rations for 12.5-40%, according to experimental groups - 9-21%.

It is known that in the last three months of pregnancy, active fetal growth increases the mares' need for nutrients more than 20% [3] (Bichon, 2004). At the same time due to the increased size of the fetus mares have a reduced ability to eat large amounts of food. Therefore, at this time the inclusion in the diet of oat and hay feed additives to promote better digestibility of nutrients of the diet is an important task of science.

In Table 7 we present our experimental data for previous years [6] (R.V. Ivanov, 2000).

In summer experience, when grazing on alas and small valley meadows Yakut mares consume an average of 330 g per day of crude protein per day per 100 kg of live weight with 211 g of digestible protein. This is according to 5 experiments.

In winter the consumption of crude protein was at 209 g per day per 100 kg of live weight on digestible protein, 136 g for an average of the four experiments data in winter pasture on natural herbage.

During summer, there is intense accumulation of reserve elements in the horses' body, increasing fatness, first by increasing muscle mass, further due to the deposition of subcutaneous fat and visceral fat in the abdomen. At this time in our experiments mares consumed 330 g per day per 100 kg of live weight.

Information is derived from 5 experiments, so they can be taken as average indicators (to date).

In winter we have data of 4 experiments for the consumption of winter pasture feed digestibility for free-grazing on natural herbage.

When mares consume 209 g of crude protein per day per 100 kg of live weight they lose fatness, therefore, usually in the second half of winter, they are tied for stationary feeding or organize feeding on

the winter pasture ground depending on the conditions of wintering and fatness.

By hay-oat diet: the rate of 10 kg of hay and 1 kg of oats per 1 head per day in the last quarter of pregnancy - mares consumed 220-250 g of crude protein per day per 100 kg of live weight (data of 2 experiments).

When replacing 1 kg of oats by feed additives it was improved nutrient digestibility of the diet and thus, increased the consumption of crude protein by 12%.

From the data of our experiments we can conclude that the need of pregnant mares in the last quarter of pregnancy may be at the level of 270-300 g of crude protein per 100 kg of body weight per day.

Table 7. The diet protein value and security of their digestible protein

| Forage | Dry matter consumption, kg | Crude protein consumption, g | | Digestible protein content in feed consumption, g | | |
|---|---|---|---|---|---|---|
| | | On one head per day, g | On 100 kg of live weight, g | On one head per day, g | On 100 kg of live weight, g | 1 kg of dry substance, g |
| Experiments on small lowland meadow in Central Yakutia | | | | | | |
| Grass sedge-gramineous at flowering | 14.1 | 1974 | 493 | 1348 | 337 | 95.6 |
| The same at the aftermath of winter pasture | 12.2 | 1074 | 268 | 611 | 153 | 50.0 |
| The same at the aftermath of winter pasture with the addition of fertilizer | 12.7 | 1403 | 351 | 916 | 229 | 110.4 |
| Winter rye at winter pasture | 16.1 | 3961 | 990 | 2824 | 709 | 175.6 |
| Experiments in the area of the Lena-Amga rivers | | | | | | |
| At normal load | 6.7 | 956 | 239 | 658 | 164 | 98.2 |
| At minimum load | 4.8 | 691 | 173 | 476 | 119 | 99.2 |
| At maximum load | 4.5 | 637 | 159 | 438 | 109,5 | 97.3 |
| Experiments in the area of alas | | | | | | |
| At normal load | 11.47 | 1307 | 338 | 831 | 208 | 72.4 |
| At minimum load | 5.5 | 1341 | 335 | 849 | 212 | 154.3 |
| At maximum load | 11.9 | 636 | 159 | 405 | 101 | 34.0 |
| Pasture rotation | 12.6 | 1209 | 325 | 793 | 198 | 63 |

This data is higher than that of riding and trotting breeds that can be explained by the fact that the Yakut horses have greater need for the exchange of energy, which in turn is due to large in comparison with other regions, the energy losses in the year-round thermoregulation stay herd of horses in the pasture. This situation is explained by the existence of an optimal regard to caloric of diet to amino acids for each stage of the life cycle of the horse, the use of feed energy is maximized to a certain ratio of energy and amino acid of diet [8] (T.J. Kuhn, 1983).

As for digestible protein is not as simple as they say.

[9] V.G. Memedeykin (2007), based on his own data and analysis of the literature suggests reviewing the needs of horses in digestible protein. The classical method of determining digestibility for input and output of the protein does not answer the fact that a portion of the nitrogen of feces is not digested, but some overcooked, i.e. have already participated in the metabolic processes of the body, and re-exuded in the intestinal lumen, and then exuded with feces.

According to the modern principles of assessing protein nutrient of feeds total protein content is of great importance, its solubility, degradability, and amino acid composition [4] (N.G. Grigoriev, etc. 1989).

We have to study the processes of bacterial fermentation in the large intestine of herd horses. By a deeper study of nutrition biology of herd horses only

then we will be able to identify the needs in digestibility, truly digestible protein of feed.

Although it seems that the very concept of a protein should be reconsidered. It can only be about the digestibility of individual amino acids.

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