Study of the influence of organomineral supplement feeds on the natural resource indicators of the live weight of horses in the Far North of Yakutia

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Abstract. The paper considers with the possibility of applying organic mineral supplement feeds from local natural raw materials in feeding Yang-type horses during the period of maximum loss of live weight in winter. In accordance with the research effort, horses from the control group that were feeding without supplement feeds, and animals from the experimental groups that were feeding organic mineral supplement feeds. During experiments, the live weight was evaluated. The biochemical structure of the blood of the experimental horses was studied. The study of the food ration of horses showed that they have a deficiency of trace elements and vitamins. Therefore, the application of organic mineral supplement feeds from local natural raw materials is justified from a practical point of view. Feeding animals from the experimental groups with supplement feeds made it possible to preserve their live weight in comparison to the control group by 0.81% and 0.5%. The improvement in horse feeding was accompanied by the normalization of the biochemical structure of blood. Thus, horses from experimental groups II and III had higher indicators of total protein by 0.43% and 0.13%, albumin by 0.17% and 0.1%, globulin by 0.26% and 0.03%, hemoglobin by 4.51% and 1.75%, as well as mineral composition (calcium was higher by 6.85% and 2.74%, phosphorus was higher by 7.62% and 2.86%). Thus, the efficiency of feeding horses with organic mineral supplement feeds in winter has been experimentally proved, which ensures maximum preservation of live weight in the Far North of Yakutia.

1. Introduction

The study of natural and climatic conditions is important in animal breeding, since these conditions are the main stress-generating factors for animals [1, 2]. It is known that the impact of sub-zero temperatures causes severe stress in the body, while the defense mechanism reacts; it is actually reflected in the clinical parameters of animals. It should be noted that the sharply continental climate of Yakutia with a long-lasting winter period of 205-220 days (temperatures from -50 to -64.4) and a short summer period (temperatures from +29.5 to +38.7) with low precipitation throughout the year create problems for animal breeding in the region.

The efficiency of animal breeding is known to depend on some factors, in particular, on the ability of animals to withstand various stress factors, for example, a change in the natural and climatic conditions of the breeding area, a level of feeding and an adopted technology of keeping, transporting,
moving and regrouping, etc., can be distinguished. Due to stress factors, losses of animal breeding products reach 39% [3].

Sapropels and derivatives of this resource are important for animal breeding as an effective supplement feeds. The use of sapropel in animal breeding increases the productivity, digestibility and nutrient metabolism. Sapropels contain deficient minerals, carotene, vitamins, and other organic substances that are found in insufficient quantities in poor quality feed. Sapropel as additional supplements in the feeding young animals contributes to an increase in the growth and development of animals, economic indicators of production. The improvements in production indicators are associated with their qualitative chemical composition, and special attention is paid to animal feeding. However, the composition of sapropels depends individually on the reservoir [4, 5, 6, 7].

The composition of hongurin includes minerals of the clinoptilolite-heulandite series, quartz, feldspars, fragments of siliceous rocks, calcite, and volcanic glass of acicular minerals. The chemical composition of hongurin is presented in table 1 [8].

| Table 1. Chemical composition of zeolite hongurin, %. |
|---------------------------------------------------|
| Chemical compound       | Contained |
| SiO₂                   | 65.11     |
| Al₂O₃                  | 12.16     |
| Fe₂O₃                  | 1.08      |
| CaO                    | 2.62      |
| MgO                    | 1.88      |
| K₂O + Na₂O             | 3.3       |
| TiO₂                   | 0.13      |
| H₂O⁺                   | 8.89      |
| H₂O⁻                   | 4.26      |

A lot of scientists published papers about the importance of improving the mineral nutrition of farm animals [9, 10, 11, 12]. Therefore, it can be concluded that, the regulation of nutrients and minerals in the food ration is of particular importance in horse feeding.

Taking into account the presented information, the combined use of sapropel and zeolite in feeding horses during the period of maximum loss of live weight is of scientific and practical interest.

The aim is to evaluate an optimal rate of organic mineral supplement feeds containing sapropel and zeolite with mineral salt for the indicators to save the live weight of horses in winters in the Far North of Yakutia.

Tasks:
- study the indicators of the live weight of horses when feeding them with organic mineral supplement feeds;
- study physiological parameters of animals.

2. Material and research methods

Organic mineral supplement feeds have been tested for the live weight of Yang type horses while the scientific experiment. The work was carried out in the conditions of the Verkhoyansk region of the Republic of Sakha (Yakutia) in the cold seasons from November to March. In the experiment, there were three groups of horses of the Yang type, ten heads each (table 2) were in the experiment.

| Table 2. Scheme of the experiment. |
|-----------------------------------|
| Groups   | N  | Feeding conditions |
| I - control | 10 | Main food ration |
II - experimental 10 Main food ration + sapropel 0.6 g/kg body weight + zeolite hongurin 0.5 g/kg body weight + Kempendyai salt 29 g

III - experimental 10 Main food ration + sapropel 0.7 g/kg body weight + zeolite hongurin 0.6 g/kg body weight + Kempendyai salt 29 g

The control group of horses did not receive organic mineral supplement feeds. Animals from experimental groups II and III received additionally sapropel in the norm of 0.6 and 0.7 g/kg of live weight, hongurin in the norm of 0.5 and 0.6 g/kg of live weight together with 29 g of Kempendyai salt.

The chemical composition of the sapropel used in the experiment is presented in table 3.

| Table 3. Chemical composition of sapropel. |
|-------------------------------------------|
| Indicators              | Unit of measurement | Contained |
|-------------------------|---------------------|-----------|
| Moisture content        | %                   | 92.42     |
| Protein                 | %                   | 2.98      |
| Fat                     | %                   | 1.87      |
| Roughage                | %                   | 0.57      |
| Ash                     | %                   | 1.95      |
| Calcium                 | %                   | 0.2       |
| Phosphorus              | %                   | 0.01      |
| Minerals                | %                   | 1.95      |

Sapropel used in scientific experiment contained in the composition of moisture content 92.42%, crude protein 2.98%, crude fat 1.87%, crude roughage 0.57%, calcium 0.2%, phosphorus 0.01%, and minerals 1.95% such as zinc, copper, cobalt, iron, selenium, molybdenum and iodine.

The efficiency of the organic mineral feed complex was established taking into account the indicators of changes in live weight and the biochemical structure of the experimental horses’ blood.

The conditions of keeping horses participating in the scientific and economic experiments were the same and corresponded to the technology adopted in the given farm.

3. Research results and discussion

The Yan type of horses bred in Yakutia in comparison to other types is characterized by the fact that they are relatively better at accumulating energy reserves in the form of fat mass for short warm periods of the year. The horse's organism uses up the stored energy optimally. According to [13], it is reflected in the meat feeding qualities of horses. The lethal qualities of animals show that the proportion of adipose tissue can have a significant part of the total mass.

In the horse breeding of the Verkhoyansk region, there are the following particularly difficult periods: the temperature of low than -14 °C or more in the fourth decade of October and a sharp cooling in the first decade of November, while the horses' organism adapts to significant temperature drops; a peak of negative ambient temperature from -50 °C reaches in December-January; spring characterized by strong gusts of wind and ice begins in March.

The main forage base for winter feeding of horses is pasture of meadows and meadows located in the forest, floodplains and old burnt areas. The influence of excessive negative ambient temperatures, as well as insufficient supply of low-quality pasture in nutrients and minerals, contribute to a rapid decrease in fatness and exhaustion of horses, this, in turn, is reflected in the loss of live weight, impairment of reproduction and also unproductive waste of animals. In spring, the territories of highlands and meadows are mastered by horses. In summer, animals graze on pastures and forest glades, landscapes in most cases are characterized as heavily overgrown with hummocks with an uneven wet surface.
A brief analysis of the economic activities of the enterprise showed that, first of all, it is necessary to reject promptly old mares and stallions in order to increase the business output. Also it is necessary to increase the proportion of replacement chicks; develop remote hard-to-reach areas, and etc. In general, the provision of fodder for horse breeding in the Verkhoyansk region covers needs of farms.

The influence of organic mineral supplement feeds on the indicators of preserving the live weight of horses of the Yang type in the conditions of the Verkhoyansk region of the Republic of Sakha (Yakutia) was also studied. For the experiment, three groups of horses were formed (a control and two experimental groups), 10 heads in each group (animals at the age 8-11 years). The average daily feed and nutrient intake for Yang horses is presented in table 4.

**Table 4.** Composition and nutritional value of the average daily food ration of Yang type horses in summer period.

| Indicators        | Norm  | Actually |
|-------------------|-------|----------|
| Pasture grass, kg |       | 36       |
| Exchange energy, MJ| 93.8  | 100.8    |
| Dry substance, kg | 11.2  | 12.06    |
| Digestible protein, g | 840  | 727.23   |
| Crude protein, g  | 1230  | 1533.5   |
| Crude roughage, g | 1900  | 3676.21  |
| Calcium, g        | 37    | 73.52    |
| Phosphorus, g     | 20    | 42.62    |
| Magnesium, g      | 15.6  | 18.03    |
| Iron, mg          | 392   | 1059.2   |
| Copper, mg        | 78    | 117.84   |
| Zinc, mg          | 280   | 391.51   |
| Cobalt, mg        | 7     | 7.11     |
| Manganese, mg     | 480   | 576.33   |
| Iodine, mg        | 7     | 7.85     |
| Carotene, mg      | 92    | 643.92   |
| Vitamin D, thousand IU | 4   | 6.84     |
| Vitamin E, mg     | 460   | 581.77   |
| Vitamin B₁, mg    | 55    | 65.98    |
| Vitamin B₂, mg    | 35    | 46.67    |
| Vitamin B₃, mg    | 80    | 83.89    |
| Vitamin B₄, mg    | 5458  | 5508.3   |
| Vitamin PP, mg    | 272   | 286.11   |

In a summer period, animals are fully provided with all the normalized nutrients, and at this time they are gaining maximum nutritional status. Another situation of the provision of normalized nutrients in the diet of horses is observed in the winter time of keeping (table 5).

**Table 5.** Composition and nutritional value of the average daily diet of Yang type horses in winter period.

| Indicators | Norm | Groups |
|------------|------|--------|
| Pasture, kg| 20   | I - control | II - experimental | III - experimental |
| Oats, kg   | 3    | 3       | 3                  |

food ration contains:
Exchange energy, MJ

|         | Norm  | Groups                  |
|---------|-------|-------------------------|
|         |       | I - control | II - experimental | III - experimental |
| Meadow hay, kg | 6    | 6                      | 6                  |
| Pasture, kg   | 12   | 12                     | 12                 |
| Oats, kg      | 2    | 2                      | 2                  |

Exchange energy: 93.8 94 94 94
Dry substance: 11.2 9.35 9.36 9.36
Digestible protein: 840 867.86 869.48 871.11
Crude protein: 1230 1161.52 1163.24 1159.3
Crude roughage: 1900 2236.5 2239.39 2242.6
Calcium: 37 68.47 69.2 70.12
Phosphorus: 29 48.84 49.15 50.38
Magnesium: 15.6 17.6 20.19 21.85
Iron: 392 1323.33 1359.71 1364.13
Copper: 78 93.8 105.83 111.62
Zinc: 280 320.65 328.71 332.1
Cobalt: 7 3.67 4 4.2
Manganese: 480 547.46 563.92 571.35
Iodine: 7 104.1 104.32
Vitamin D, thousand IU: 4 3 3.02 3.03
Vitamin E, mg: 460 346.19 340.84 347.99
Vitamin B1, mg: 55 31.85 31.35 32.16
Vitamin B2, mg: 35 39.72 40.87 41.30
Vitamin B3, mg: 80 65.1 65.59 65.24
Vitamin B4, mg: 5458 2110 2121.52 2060.3
Vitamin PP, mg: 272 149.87 150.3 151.14
Vitamin B6, mg: 280 325.8 338.52 343.34
Vitamin B7, mg: 7 4.7 4.9

The winter food ration of horses, compared to the summer food ration, is deficient in the element such as cobalt, iodine, vitamins D, E, PP and group B in several ways. For better maintenance of vital functions, preservation of fatness, they are feeding with hay during a particularly cold period of the year. The average daily ration of horses with hay feeding is presented in Table 5.

Table 6. Composition and nutritional value of the average daily ration of Yang type horses in winter period with hay feeding.

| Indicators                  | Norm  | Groups                  |
|-----------------------------|-------|-------------------------|
|                             |       | I - control | II - experimental | III - experimental |
| Meadow hay, kg              | 6     | 6                      | 6                  |
| Pasture, kg                 | 12    | 12                     | 12                 |
| Oats, kg                    | 2     | 2                      | 2                  |

Exchange energy: 93.8 94 94 94
Dry substance: 11.2 9.35 9.36 9.36
Digestible protein: 840 867.86 869.48 871.11
Crude protein: 1230 1161.52 1163.24 1159.3
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Table 7. Feed consumption for the Yang type horse maintenance.

| Feeds          | Average daily feeding | Duration of the period, days | Required for the feeding period, kg | Feeds contain |
|----------------|-----------------------|-----------------------------|-------------------------------------|---------------|
| Norm           | -                     | -                           | -                                   | -             |
| Meadow hay, kg | 6                     | 40                          | 240                                 | 13440         |
| Pasture, kg    | 16                    | 150                         | 2400                                | 7680          |
| Oats, kg       | 2.5                   | 150                         | 375                                 | 3750          |
| Total          | -                     | -                           | -                                   | 13086         |
| Protein level in the diet, g/ECU | -                     | -                           | -                                   | 93.35         |
| Provision, %   | -                     | -                           | -                                   | -             |

Animals’ food ration meets the feeding standards for dry substance, metabolic energy, crude protein, crude roughage and some of others. For microelements such as cobalt and iodine, their deficiency is observed in the food ration according to the feeding norms [14, 15].

At the beginning of the experiment, no significant differences were found in the live weight of horses, but the changes were recorded at the end of the scientific and economic experiment (Table 8).

Table 8. Change in live weight of horses (M ± m, n = 10), kg.

| Groups        | Average live weight | Difference, kg |
|---------------|---------------------|----------------|
|               | at the beginning of the experiment, kg | at the end of the experiment, kg |
| I - control   | 443.8±2.57          | 418.1±2.65     | -25.7±2.05          |
| II - experimental | 443.5±2.83      | 421.5±2.02     | -22±1.48           |
| III - experimental | 444.2±2.42     | 420.2±1.13     | -24±1.43           |

Thus, a control group of horses consuming the main food ration was inferior to the animals of the II and III experimental groups by 3.4 and 2.1 kg or 0.81% and 0.5%.

The blood biochemical structure Yang type horses was studied to control their physiological state (Table 9).
Table 9. Biochemical structure of the Yang type horses’ blood when feeding organic mineral supplement feeds (M±m).

| Indicators          | Norm at the beginning of the accounting period | Groups at the end of the accounting period |
|---------------------|-----------------------------------------------|---------------------------------------------|
|                     | I - control                                  | II - experimental                           | III - experimental                         |
| Total protein, %    | 7-9                                          | 8.20±0.12                                   | 8.13±0.32                                   | 8.07±0.15                                   |
| Albumin, %          | 3-5                                          | 3.47±0.03                                   | 3.43±0.09                                   | 3.4±0.12                                    |
| Globulin, %         | 3-6                                          | 4.73±0.12                                   | 4.7±0.25                                    | 4.67±0.03                                   |
| Phosphorus, mmol/l  | 0.7-1.4                                      | 1.03±0.01                                   | 1.02±0.01                                   | 1.02±0.01                                   |
| Calcium, mmol/l     | 2.65-3.25                                    | 2.85±0.16                                   | 2.82±0.2                                    | 2.83±0.1                                    |
| Hemoglobin, g/l     | 110-170                                      | 132.33±8.97                                 | 131.67±2.85                                 | 130±4.16                                    |
|                     |                                               |                                             |                                             |                                             |
| Total protein, %    | 7-9                                          | 8.37±0.09                                   | 8.8±0.1*                                   | 8.5±0.1                                    |
| Albumin, %          | 3-5                                          | 3.6±0.12                                    | 3.77±0.03                                   | 3.7±0.06                                    |
| Globulin, %         | 3-6                                          | 4.77±0.19                                   | 5.03±0.12                                   | 4.8±0.06                                    |
| Phosphorus, mmol/l  | 0.7-1.4                                      | 1.05±0.01                                   | 1.13±0.01*                                  | 1.08±0.01                                   |
| Calcium, mmol/l     | 2.65-3.25                                    | 2.92±0.08                                   | 3.12±0.07                                   | 3±0.07                                     |

Note: *P>0.95; **P>0.99

The study of the biochemical blood profile of the experimental horses found that the use of organic mineral supplement feeds had a positive effect on the blood structure. Thus, a control group of horses yielded to animals from II and III experimental groups in total protein by 0.43% (P > 0.95) and 0.13%, albumin by 0.17% and 0.10%, globulin by 0.26% and 0.03%, hemoglobin by 4.51% and 1.75%, phosphorus by 7.62% (P > 0.99) and 2.86%, calcium by 6.85% and 2.74%, respectively.

4. Conclusion

The conducted studies that determine the effect of organic mineral supplement feeds on the indicators of preserving the live weight of horses found that when the supplement feeds were included in the food ration of the experimental groups, they contributed to the preservation of live weight by 3.4 and 2.1 kg or 0.81% and 0.5%.

This is due to the improvement of metabolism, which is evidenced by the biochemical structure of the horses’ blood in the experimental groups. In the horses’ blood in experimental groups II and III, the total protein averaged 8.8 ± 0.1 and 8.5 ± 0.1% versus 8.37 ± 0.09% in the control group. The similar information of superiority goes to the level of hemoglobin, so in the experimental groups it was 139 ± 1.73 and 135.33 ± 2.03 g/l, while in the control group it was 133 ± 6.81 g/l. In mineral metabolism, the difference was also established in the superiority of the experimental groups (calcium 1.13 ± 0.01 and 1.08 ± 0.01 mmol/l; phosphorus 3.12 ± 0.07 and 3 ± 0.07 mmol/l) over the control group (calcium 1.05 ± 0.01 mmol/l and phosphorus 2.92 ± 0.08 mmol/l).

Thus, the inclusion of organic mineral supplement feeds from natural raw materials in the food rations of horses contributes to a significant preservation of live weight and an improvement in metabolism.

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