

Original research

Effect of complete pelleted alfalfa forages on growth and adaptation of horses

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Abstract. The successful development of horse breeding requires the search for new technological solutions, the use of which will improve the quality and reduce the cost of compound feed. At the same time, it is important to breed and maintain horses with high adaptive capacity, capable of withstanding the action of negative environmental factors without reducing their performance. Sport horses require special treatment and an individual approach in the selection of diet and breeding conditions. We investigated the effect of granulated feed containing alfalfa and mineral-vitamin complex. Haemoglobin level in the studied animals amounted to 152.6 g/L, 8.1% higher than in control peers. The 15.1% higher content of erythrocytes in blood in horses of the experimental group may indicate more intensive blood saturation. The analysis of variance revealed a significant and highly probable influence of feed on haemoglobin content, number of erythrocytes and leukocytes in the horses' blood, the share of influence for which was the greatest and ranged from 56.4 to 66.0%. It was found that the greatest positive correlation was observed between the amount of consumed dried alfalfa and the level of haemoglobin, colour index, number of erythrocytes and leukocytes in the blood of young horses ($r=0.32 \pm 0.10$; 0.26 ± 0 ; $r=0.43 \pm 0.25$; $r=0.41 \pm 0.09$, respectively). It was also found that horses in the experimental group were more heat tolerant compared to the control group horses indicating their greater adaptability. The experimental horses' body temperature measured immediately after their walk was 38.2 °C, which was 0.8% lower than in the control group. One hour after the walk, their body temperature was almost the same as at rest (37.9 °C). In horses of the control group during the same period, the body temperature was 38.0 °C, which is 0.4 °C higher than their temperature at rest before the walk. The use in the diets of the studied animals of full-fed pelleted forages allowed raising animals of strong physiques, having more intensive metabolism and more pronounced adaptive and compensatory abilities in comparison with their peers of the control group.

Keywords: young horses; diet; weight dynamics; body measurements and indices; heat resistance; haematological indices

Вплив повнораціонного гранульованого корму з люцерни на ріст та адаптацію коней

Анотація. Для успішного розвитку конярства необхідний пошук нових технологічних рішень, використання яких дасть змогу поліпшити якість і зменшити вартість комбікормів. Водночас актуальним є виведення та утримання коней з високою адаптаційною здатністю, здатних протистояти дії негативних факторів середовища без зниження їхньої продуктивності. Спортивні коні потребують особливого ставлення та індивідуального підходу в підборі раціону та умов утримання. Ми досліджували вплив гранульованого комбікорму, що містив люцерну та мінерально-вітамінний комплекс. Дослідженнями встановлено позитивний вплив використання повнораціонного гранульованого корму з люцерни в годівлі коней української верхової породи на інтенсивність їх росту і розвитку та адаптаційні якості. Жива маса піддослідних тварин на початку досліджень становила 190,0 кг, в подальшому підвищення живої маси молодняку коней дослідної групи порівняно з контролем становило 8,8–10,1% залежно від віку. Відмічено позитивний вплив кормового продукту на гематологічні показники крові тварин. За переважною більшістю вивчені показники відповідали фізіологічній нормі. Рівень гемоглобіну у дослідних тварин становив 152,6 г/л, що на 8,1% більше за контрольних ровесників. Перевага за вмістом еритроцитів в крові у коней дослідної групи (на 15,1%) свідчить про більш інтенсивне насичення крові киснем. Дисперсійним аналізом виявлено значний і переважно високо вірогідний вплив споживання корму на вміст гемоглобіну, кількості еритроцитів і лейкоцитів в крові коней, частка впливу на які становила від 56,4 до 66,0%. Найбільший позитивний корелятивний зв'язок встановлено між кількістю споживання дослідного корму із висушеної трави люцерни та рівнем гемоглобіну, кольорового показника, кількістю еритроцитів та лейкоцитів в крові молодняку ($r=0,32 \pm 0,10$; $0,26 \pm 0$; $r=0,43 \pm 0,25$; $r=0,41 \pm 0,09$). Також виявлено, що коні дослідної групи були

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більш теплостійкими ніж контрольні тварини, що свідчить про більшу їх адаптаційну здатність. Температура тіла коней відразу після прогулянки у коней дослідної групи становила 38,2 °С, що на 0,8% нижче, ніж у контрольних коней. Через годину після прогулянки температура їх тіла була майже такою самою, як і у стані спокою (37,9 °С). У коней контрольної групи в цей час була відмічена температура тіла на рівні 38,0 °С, або на 0,4 °С вище, ніж у стані спокою. Застосування повноцінного гранульованого корму в раціонах годівлі дослідних тварин дало можливість сформувати тварин міцної конституції з більш інтенсивним обміном речовин та більш вираженими адаптивними і компенсаторними можливостями порівняно з однопітками контрольної групи.

Ключові слова: молодняк; раціон; динаміка ваги; проміри та індекси тіла; термостійкість; гематологічні показники

Introduction

A precondition for the horse breeding industry development is the improvement of horse feeding techniques and the search for new technological solutions in the production of food, which will reduce the cost of feedstuff. At the same time, the problem of breeding and keeping horses with high adaptability, able to withstand negative environmental factors without productivity loss, is still pressing (Halatyuk, 2016; Normando, 2003).

Sport horses require special treatment and an individual approach. They require a particular structure of the diet, and husbandry, and are sensitive to changes in the daily routine (Yegorov, 2017). Their main product is maximum muscle work. Therefore, the dietary energy supply is very important for them.

The main task of feeding horses is to provide them with a sufficient amount of nutrients and biologically active compounds to maintain the vital functions of the body and compensate for the metabolic costs of muscle function. The daily nutritional needs of working horses depend on the work they perform, their health, age, breed, etc. (Andrijchuk, 2013; Lesnovska, 2017).

The sport horses' needs for nutrients depend on their live weight, temperament, and work performed (training, testing, rest). During the training and testing period, the need for energy increases by 32.0%, for protein and lysine – by 13.0%, minerals – by 12.0%, including table salt – by 80.0%, vitamin A – by 85.0%, D – by 66.0%, E – by 37.0%, and B group – by 15.0-80.0% compared to the horses at rest. Body tension reduces during exercise only when optimal feeding conditions are provided (Hannan, 2006; Normando, 2003).

The idea that the oats and hay introduced into the diet of horses fully provide them with all the necessary nutrients, vitamins, microelements, and macroelements has long been refuted. After all, it is known that in different ecological and geographical zones, even on different fields of the same farm, the chemical composition of feed is not the same.

In many countries, lucerne (alfalfa) is used as the main fodder crop in animal diets. It has optimum characteristics and is suitable for the manufacture of various types of feed: hay, haylage, grass meal, chopped straw, pellets, briquettes, and combined silage. High-quality haylage, hay, vitamin grass meal, granules, and briquettes are produced from herbage.

Horses digest concentrated feeds very well, especially cereals, while coarse feeds can be digested not so well since they contain a lot of fibers. However, coarse fodder is one of the main components of the horse diet and accounts for 50.0% or more of the total nutritional content of the diet. Therefore, dried alfalfa grass in the form of granules with vitamins, and micro- and macroelements added is a better choice.

The purpose of the research was to clarify the effect of feedstuff made from lucerne grass on the growth and adaptability of young horses of the Ukrainian Saddle Horse breed.

Materials and methods

The research used the feedstuff made from artificially dried lucerne (alfalfa) grass.

We studied young horses of the Ukrainian Saddle Horse breed during the period from 2019 to 2020 at the municipal extracurricular educational institution «Specialized Children and Youth Sports School of the Olympic Reserve in Equestrian Sports» (Dnipro, Ukraine). The experimental period lasted for 12 months.

Groups of animals were formed according to the method of comparing groups (experimental and control groups). The number of horses in each group was 12 animals (6 mares and 6 stallions). The live body weight of the animals under study averaged 190.0-190.3 kg at the beginning of the experiment.

The quality of complete granulated feed was rated according to DSTU 4687-2006 «Artificially Dried Herbal Feed» and SOU «Intensive Drying Herbal Feed. Standard Procedures.» (DSTU, 2006).

Table 1 – Composition and nutritional content of the feedstuff*

Chemical composition on a dry basis	Indicator
Total moisture, %	9.3
Protein, %	18.1
Crude fibre, %	19.4
Crude ash, %	8.2
Crude fat, %	1.4
Calcium, %	2.16
Phosphorus, %	0.37
Carotene, mg	160.0
Fodder units, %	0.69

Note: * Composition of the granulated product: lucerne – 96.4%, mineral-amino acid complex – 3.6%.

Table 2 – Horse diet structure of different experimental groups, %

Diet component	Group	
	I (control)	II (experimental)
Oats	30.0	30.0
Grain and legume hay	48.0	48.0
Corn grain	12.0	–
Carrots	5.0	5.0
Wheat bran	5.0	5.0
Complete granulated feed (CGF)	–	12.0
Total	100.0	100.0

Feeds used for horse feeding are the products of plant origin. Over 40.0% of the structure of a horse's diet should include coarse feeds rich in fiber. Dried lucerne is used in diets more often today. Table 1 shows the composition of a complete granulated feed made from dried lucerne grass used during our studies.

The feed consumption rate for young horses with a live weight of 450-500 kg is 1.5-2 kg per day in dry form or mixed with water in a ratio of 1:2. Thus, this feed product based on artificially dried lucerne grass makes it possible avoid overfilling the stomach of young horses. The horse diet structure of different experimental groups is shown in Table 2.

In the structure of the diet of horses of both groups under study, cereal and legume hay (48.0%) and oats (30.0%) are the largest share. Corn grains in group I (control group) and complete granulated feed (GCF) in group II (experimental group) account for 12.0% each. Other components of the diet (carrots and wheat bran) are 5.0% each.

Features of the horse exterior were measured by standard linear measurements. Based on the measurements, the body structure indices of young animals were determined (%):

1. Format index = body length/withers height × 100;
2. Chest girth index = chest girth/withers height × 100;
3. Blockiness index = chest circumference/body length × 100.

A hematological blood test was performed using conventional methods (Khnanisho, 2020). Blood for the study of hematological parameters was taken from the jugular vein in the morning before feeding. White blood cell and red blood cell counts were estimated by the Goryaev chamber calculation method. Hemoglobin level was measured using the Sahli method. The erythrocyte sedimentation rate was estimated using the Panchenkov apparatus. The blood color

index was calculated using the formula:

$$Hb_2 = Er_1 / Er_2 \times Hb_1,$$

where Hb_2 is the amount of hemoglobin in the animal under study;

Er_1 is the red blood cell count in the animal under study;

Hb_1 is the average normal amount of hemoglobin in an animal of this species;

Er_2 is the normal average red blood cell count in an animal of this species;

The degree of heat resistance was determined as a marker of the adaptive ability of horses. For this purpose, the «walk test» according to the Bonsma method (Bonsma, 1949).

Animals' adaptability to environmental conditions was estimated by measuring the overall clinical parameters.

The degree of heat resistance of horses was assessed in summer (in July). According to the methodology, the body temperature was measured (per rectum) in the horses of the experimental and control groups for 10 days before the walk, immediately after the walk, and 1 hour after the walk. The walk was daily, from 15:00 to 16:00. The duration of the walk was 1 hour. To determine the parameters of the microclimate, the air temperature was measured with a mercury thermometer located in the stall, the humidity was also measured in the stall and the riding arena.

The results of the studies have been statistically processed and represented using Statistica 12.0. The probability of the difference between the values in the animals of the experimental and control groups was assessed using the Student's t-test ($p < 0.05$; $p < 0.01$; $p < 0.001$) after checking the normality of distribution and the difference between the general variances.

Table 3 – Dynamics of linear measurements and indices of body structure

Measurements	Age, months					
	12		18		24	
	I	II	I	II	I	II
Measurements, cm						
Withers height	139.1 ± 3.47	142.1 ± 2.47*	144.1 ± 3.15	152.1 ± 2.96**	146.2 ± 5.76	154.7 ± 4.62
Chest circumference	149.6 ± 2.84	154.3 ± 3.22*	160.3 ± 4.05	171.2 ± 3.83*	162.1 ± 4.53	174.9 ± 3.98**
Transverse body length	139.8 ± 3.11	143.0 ± 3.89*	144.9 ± 3.17	153.2 ± 3.62**	148.9 ± 5.16	158.2 ± 4.76*
Body indices, %						
Format	100.5 ± 5.23	100.6 ± 5.61	100.5 ± 4.72	100.7 ± 6.23 **	101.8 ± 5.37	102.3 ± 4.61
Chest circumference	107.5 ± 3.89	108.6 ± 5.11*	111.2 ± 3.95	112.6 ± 4.77	110.8 ± 7.21	113.1 ± 5.49
Compactness	107.0 ± 6.12	107.9 ± 5.89	110.6 ± 4.53	111.8 ± 6.18*	108.8 ± 6.24	110.6 ± 7.19*

Note. Probability of difference: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Results

The effect of the use of complete granulated lucerne feed on the growth and development of young horses was estimated by the dynamics of linear measurements, and based on the measurements made in different periods of growth, the dynamics of body structure indices were established (Table 3).

It was recorded that at the age of 12 months, young animals of group I were inferior to their peers of group II, who consumed complete granulated feed, by all linear measurements. Thus, the difference in withers height was 2.2%, chest circumference – 3.1%, transverse body length – 2.3%. Further on, this advantage in favor of young animals consuming the experimental diet was maintained. At the age of 18 months, it was 5.6%; 6.8%, and 5.7%, respectively, at the age of 24 months – 5.8%; 7.9%, and 6.2%, respectively.

The dynamics of the body structure indices of the young animals under study confirmed the intensity of growth and development of horses that consumed complete granulated feed as their diet. Thus, at the age of 12 months, the index of the format characterizing the relative withers height of animals compared to the body length, in young animals of group II was greater than that of their peers of group I by 0.1%. Subsequently, at the age of 18 and 24 months, the horses of group II outperformed their peers of group I by 0.2 and 0.5%, respectively.

The chest circumference index, demonstrating sufficient development of the anterior part of the body, where the lungs are located, on which the intensity of oxygen supply to all organs of the animal depends, as compared to the withers height, was greater in all study periods in young animals of group II. Thus, according to this index, animals of group II outperformed their peers in group I at the age of 12 months – by 1.1%, at the age of 18 months – by 1.4%, and at 24 months – by 2.3%, respectively.

According to the blockiness index, which indicates the relative development of chest circumference compared to the body length, young animals of group II outperformed their peers of group I at the age of 12 months – by 0.9%. Further on, a rise in this index in young animals of group II was recorded: at the age of 18 months – by 1.2%, at 24 months – by 1.8%, which confirms a more intensive growth of the chest compared to the length of the body.

In addition, during the research, the live weight of horses of different groups was measured (Table 4).

An increase in the live weight of young animals of group II consuming complete granulated feed from dried lucerne, as compared to peers of group I, was recorded. Thus, at the age of 12 months, the animals of group II outperformed the young animals of group I by 9.0%, and at 18 months – by 10.1%, respectively. At the end of the research (at the age of 24 months), the young animals of group II had a live weight of 452.6 kg, which is 8.8% more than in colts of group I.

When the conditions of feeding and keeping horses are violated, the most important nutrients in terms of energy are lost, and therefore their efficiency decreases. In cases where the unsystematic operation of horses does not meet the conditions for ensuring favorable factors of vital activity of the body, they have to adapt to such circumstances with greater tension of physiological systems. In many animals, this results in stress, accompanied by a decrease in productivity and deterioration of the overall health of horses.

Blood is of considerable interest as an object of scientific research, since hematological indicators to some extent reflect the intensity and trends of metabolic processes in the body. An important aspect of feeding and training of the Ukrainian Saddle Horses is the breeding of animals with a strong constitution and naturally high resistance to diseases and stress factors. In this regard, we conducted studies to determine the hematological parameters of the blood of Ukrainian Saddle Horses at the age of 24 months (Table 5).

The results of studies on the hematological parameters of blood (Table 5) indicate that the vast majority of indicators correspond to the physiological standard (Kryvoshyia, 2015). The analyzed blood composition is natural and indicates the changes in the body of horses during the entire period of research. It should be noted that the obtained hematological profile is the basic characteristic of the state of health of horses at the enterprise under study.

However, when comparing the blood properties of the horses of the experimental and control groups, differences were found between them. In the horses of the experimental group, the numbers were higher but did not go beyond the physiological standard.

The hemoglobin level in the animals under study was 152.6 g/l, which is 8.1% higher than that in the control peers. The red

Table 4 – Dynamics of live body weight of young animals under study, kg

Age, months	Groups under study		± to control	
	I	II	kg	%
9	190.0 ± 1.97	190.3 ± 2.11	0.3	0.2
12	265.5 ± 1.53	289.3 ± 1.73	+23.8	+9.0
18	354.0 ± 2.62	389.8 ± 2.70	+35.8	+10.1
24	416.0 ± 3.15	452.6 ± 3.44	+36.6	+8.8

Table 5 – Hematological parameters of horse blood

Indicator	Physiological standard	Horse Group	
		I	II
Hemoglobin, g/L	110–190	141.2 ± 18.45	152.6 ± 19.42
Hematocrit, %	34–45	36.7 ± 1.97	38.2 ± 2.14
Red blood cells, 10 ¹² /L	7–10	7.3 ± 1.08	8.4 ± 1.24
White blood cells, 10 ⁹ /L	7–12	7.8 ± 1.19	7.9 ± 1.46
Platelets	400–800	627.5 ± 38.13	610.9 ± 35.7
Color index, units	0.86–1.05	0.9 ± 0.11	1.0 ± 0.17
Erythrocyte sedimentation rate (ESR) mm/h.	20–50	32.5 ± 3.41	28.0 ± 3.05

Table 6 – Proportion of effect and correlation coefficients between the amount of feedstuff consumed and the hematological parameters of horse blood

Indicator	Proportion of effect, %	r
Blood hemoglobin content	66.0 ***	0.32 ± 0.11
Red blood cell count	62.6***	0.43 ± 0.22
White blood cell count	56.4***	0.26 ± 0.00
Colour index	4.0	0.41 ± 0.09
Erythrocyte sedimentation rate (ESR)	3.7	0.15 ± 0.96

Note. Probability of difference: *p < 0.05; **p < 0.01; ***p < 0.001

blood cell count in the horses of group II was 15.1% greater, which indicates a more intense oxygenation of the blood.

It should be noted that the erythrocyte sedimentation rate (ESR) was slightly lower in the young animals of the experimental group and was 28.0 mm/h. The difference in the white blood cell count was 1.3% by group.

To determine the proportion of the effect of feedstuff consumption on the hematological parameters of horse blood, a dispersion analysis of a one-factor complex was conducted (Table 6).

The analysis revealed a significant and mostly highly probable effect of the feedstuff on hemoglobin contents, the number of red blood cells and white blood cells in horses, the share of influence of which was the largest and varied from 56.4 to 66.0%.

The stress of metabolism and energy during the training of sport horses naturally affects their functional status. Our studies indicate that there are correlative links between the hematological parameters of horse blood and the consumption of complete granulated feed (Table 6). The data show that the greatest positive correlative relationship was between the amount of the consumed complete granulated feed under study made from dried lucerne and the level of hemoglobin, color indicator, the number of erythrocytes and leukocytes in the blood of horses ($r=0.32\pm 0.10$; 0.26 ± 0 ; $r=0.43\pm 0.25$; $r=0.41\pm 0.09$).

For horses, the degree of adaptability is the coefficient of heat resistance. Heat resistance is the property of preserving the reproductive function, normal growth, and productivity inherent in animals in hot climates. This is the property of maintaining temperature homeostasis and the relationship with this property is an adaptive response to high ambient temperature conditions.

Heat resistance is the ability to keep the adaptability of animals while maintaining productive qualities and reproductive functions in response to changes in the temperature environment.

Of the many factors that determine the adaptability of animals, physiological ones are the most complex and important, because, in combination with climatic factors, they affect the body in a complex way. Therefore, in our studies, we measured the rectal temperature in the horses of the experimental and control groups (Table 7).

According to the obtained data (Table 7), the body temperature of the horses immediately after the walk was 38.2°C in the horses of the experimental group, which is 0.8% lower than in the control horses. It should be noted that an hour after the walk, the temperature of the horses of the experimental group was almost the same as at rest (37.9°C). In the horses of the control group, the body temperature was 38.0°C at the same period, or 0.4°C higher than at rest.

Consequently, the horses of the experimental group, which consumed complete granulated lucerne feed as part of their diet, restored the temperature constant of the body faster than the control animals, which indicates a greater adaptive ability.

Discussion

Intensification of sports focus in horse breeding is only possible through the development and implementation of advanced technological solutions for horse breeding (Andrijchuk, 2013).

Determining the potential of horses intended for use in classical equestrian sports requires an in-depth comprehensive study of their anatomical, morphological, physiological, and biochemical parameters, which play an important role in a particular type of motor activity and application. According to recent studies (Petrushko, Kabasova, 2018; Dynnikova et al., 2019), horses should be examined at least two or three times a week. This allows the detection of changes in their behavior at training loads and preventing respiratory diseases.

The quality of feeding of horses significantly affects the state of their health, shaping performance traits, including body type, maturing rate, and endurance (Dynnikova et al., 2019, 2020). It has been proven that a balanced diet determines the potential for the implementation of genetic merits by 50.0-55.0%, which determines further use and reproductive longevity of animals (Guanggang, 2012; Yegorov, 2017).

Some positive effects of granulated feed from dried alfalfa on the intensity of growth and development of young horses were recently established (Dynnikova et al., 2020). It was noted that when 12% of this feed product was introduced into the diet, the increase in the live weight of horses averaged 8.0–9.8%.

Table 7. Indicators of heat resistance of the Ukrainian Saddle Horses

Indicator	Horse Group	
	I	II
Relative humidity in the horse arena, %	40.8 ± 0.32	40.8 ± 0.32
Air temperature in the horse arena, °C	32.04 ± 0.713	32.04 ± 0.713
Relative humidity in stall, %	57.2 ± 1.72	57.2 ± 1.72
Air temperature in stall, °C	23.1 ± 1.21	23.1 ± 1.21
Horse body temperature in the stable, °C	37.6 ± 0.07	37.8 ± 0.03
Horse body temperature immediately after a walk, °C	38.5 ± 0.12	38.2 ± 0.09
Horse body temperature 1 hour after walking, °C	38.0 ± 0.14	37.9 ± 0.10

Our experimental studies have established that when the dosage of this feed in the diet was reduced to 10.5%, the intensity of live weight gain in young animals increased by 10.1%. In addition, our research has proven the positive effect of that feed product on the heat resistance of horses: young animals recovered their body temperature faster, which indicates their better adaptive capacity. Otherwise, imbalanced diets and deficiency of some nutrients lead to a deterioration in the health of horses and result in metabolic disorders in individual organs (Cymbaluk, 1994).

Conclusions

It has been established that the use of a feedstuff based on dried lucerne for feeding sports horses contributes to improved overall health, which in turn increases the endurance and effectiveness of training and testing. The use of complete granulated feed in diets of animals under study made it possible to grow animals of strong body composition with more intensive metabolism and more pronounced adaptive and compensatory abilities compared to peers of the control group.

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