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EFFECT OF HUMIC FEED ADDITIVE ON METABOLIC PROCESSES AND PRODUCTIVITY OF BEEF CATTLE

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Abstract

The use of made-in-Kazakhstan organic and mineral feed additives to in-crease the meat productivity of cattle is important for the agro-industrial complex of the Republic. During the study, qualitative and quantitative analysis of raw materials was made. Quality control of the finished feed additive was carried out following the requirements of the State Pharmacopoeia of the Republic of Ka-zakhstan. The studies were conducted in accordance with the requirements of the Technical Regulations approved by the Decree of the Government of the Repub-lic of Kazakhstan dated April 23, 2008 No. 380, Regulation No. 7-1/625 dated 11/28/2014 and Regulation (EC) No. 1831/2003 of the European Parliament and of the Council of September 22, 2003, on additives for use in animal feeding. Ka-zakh potassium humate of the Maykubensky deposit is sterile, non-pyrogenic, non-toxic, and harmless, with an average pH of 11.0-1.0, and has a biological ef-fect on laboratory animals (white mice). The effectiveness analysis in the produc-tion experiment allowed us to identify the positive effect of feed additives on metabolic processes and increasing meat productivity in bulls. Regardless of age, on the 7th day of taking the feed additive of potassium humate, the calves' coats acquired a noticeable shine and a bright color, and shedding was completed with-in a month. Clinical signs of metabolic disorders and vitamin deficiency, detected in the farm at the time of the experiment in some animals, pass through 20-30 days from the beginning of the application of the feed additive. The optimal scheme for the use of feed additives was tested on the Kazakh meat breed Akbas, and the concentration of humic substances was selected for the maximum mani-festation of the biologically active effect. Animals became mobile and active, their rumination became more active, they grew noticeably, and the average daily weight gain increased by 7.6-8.9%.

Key words: cattle; feed additive; humic substances; meat productivity; po-tassium humate.

Introduction

The program implemented by the Government of the Republic of Kazakh-stan for the development of beef cattle breeding primarily involves the importa-tion of highly productive livestock from abroad, such as Angus, Aubrac, Here-ford, etc. In most cases, these are animals with productivity from 1,000 g to 2,400 g of daily weight gain and the formation of marbled meat. High meat productivity of livestock and high-quality meat products require a new approach to animal feeding [1].

The use of made-in-Kazakhstan feed additives to increase the meat produc-tivity of cattle is important for the agro-industrial complex of the Republic. This will reduce the cost of beef and also the cost of purchasing and importing similar feed additives from abroad [2].

In recent years, there has been a growing interest in humic substances in an-imal diets. Humic substances are natural organic substances formed in the soil during the humification of dead organic matter. Their main components are hu-mic acids, fulvic acids, and humins. Humic substances are a rich source of easily digestible minerals. They are considered natural and safe feed additives with many positive effects, including improving animal welfare and the quality of an-imal products [3, 4].

Humic acids are part of the organic mass of

peat, coal and brown coal, sludge, some soils, and lignosulphonate, from which they are extracted by treat-ment with weak aqueous alkali solutions [5].

Humic acids are complex high-molecular compounds of an aromatic nature. The main structural unit consists of a flat grid of cyclically polymerized carbon with side branched chains that carry various functional groups: carboxyl, hy-droxyl, phenolic, methoxy, quinoid, and others that are responsible for the reac-tivity of humic acids [6, 7].

In the last decade, there has been a growing interest in the use of humic substances in agriculture, medicine, and biology [8]. Humic substances with a high proportion of humic acids (more than 40%) have been classified by the European Commission as feed materials that can be used in animal nutrition since 2013 [9].

Due to its redox properties, humic acid can reduce iron (III) to iron (II) in aqueous conditions in a wide range of pH values (from 4.0 to 9.0). Humic acids can restore and release iron from ferritin reserves, as well as promote lipid peroxidation. This contributes to the normalization of metabolic processes in animals and humans [10].

According to scientific research, humic acids, improving digestion and as-similation of feed, optimize the condition of the gastrointestinal tract of animals. Replacing antibiotics (added to feed as growth stimulants) with humic acids im-proves the productivity and condition of animals, namely, daily weight gain and feed intake [11].

Humic acids, as natural components of humus, constantly enter the animal body with pasture grasses, feed, or natural or special feed additives, are included in metabolic processes, are completely metabolized in the cell, and are assimilated without a trace in the animal's body, acting as additional sources of biologically active substances, namely, various mineral compounds. They have a positive ef-fect on the general condition and normalize the metabolic processes of the body at the molecular level. Therefore, products obtained from animals that received the preparation can be used without any restrictions [12].

In Russia, humic preparations have been widely used for feeding farm ani-mals and plants since the beginning of the second half of the 20th century. To in-crease the weight gain of animals and strengthen the general nonspecific re-sistance of the organism, in 1987 the Presidium of the Veterinary Pharmacologi-cal Council under the General Directorate of Veterinary Medicine of the USSR, based on the results of state production tests, decided to use ballast-free sodium humate as a feed additive in the cattle and poultry diets [13].

In Kazakhstan, humic substances in the form of sodium humate or potassi-um humate are obtained from brown or stone coal [14]. The use of made-in-Kazakhstan preparations based on humic acids in meat husbandry would allow to activate metabolic processes and increase weight gain in animals.

The purpose of the study is to determine the qualitative indicators of po-tassium humate and the effectiveness for animals of the «Gumka-KZ» feed addi-tive based on Kazakh raw materials.

Research objectives:

1. Determination of organoleptic and physico-chemical properties of potas-sium humate;

2. check of sterility, pyrogenicity, toxicity and harmlessness of potassium humate and finished feed additive;

3. Analysis of the organoleptic properties of the finished feed additive;

4. quantitative analysis of potassium humate content in feed additive;

5. analysis of the biological activity of the feed additive on laboratory ani-mals and in production experiments.

Materials and methods

Potassium humate was obtained and analyzed at the Institute of Coal Chemistry and Technology Limited Liability Partnership (LLP); the development and quality control of the feed additive were carried out at the Laboratory of Mycology and Biotechnology of Fungi at the Kazakh Agrotechnical Research Uni-versity named after S. Seifullin; infrared (IR) spectrometry of the feed additive was carried out at the Provost Office (Collective Use Office of the Nazarbayev University Autonomous Educational Organization (AEO)).

The object of the study:

- Four samples of potassium humate of Kazakh origin obtained from brown coals mined in Kazakhstan.

The control of appearance, pH, sterility, pyrogenicity, toxicity, and harmlessness of raw materials and finished feed additives was carried out following the requirements of the State Pharmacopoeia of the Republic of Kazakhstan [15]. The studies were conducted in accordance

with the requirements of the Technical Regulations approved by the Decree of the Government of the Republic of Kazakhstan dated April 23, 2008 No. 380, Regulation No. 7-1/625 dated 11/28/2014 and Regulation (EC) No. 1831/2003 of the European Parliament and of the Council of September 22, 2003, on additives for use in animal feeding.

IR spectroscopy was performed on the Shimadzu IR Prestige-21 IR Fourier spectrometer with the Miracle attenuated total internal reflection (ATIR) attach-ment produced by the Pike Technologies. IR spectrometry for the qualitative con-tent of humic substances was carried out on a Nicolet iS 10 IR Fourier spectrom-eter, with an average mass of the analyzed sample equaling 2 ml. Quantitative analysis of potassium humate was carried out by ultraviolet (UV) spectrometry on the Evolution 300 UV-VIS Spectrophotometer equipment manufactured by Thermo Scientific. The work on the spectrometers was carried out according to the manufacturer's instructions.

Laboratory animals (white mice) from the S.Seifullin KATU vivarium were used to study harmlessness, acute toxicity and biological activity. Laboratory tests of the harmlessness, toxicity, biological activity of the preparation were carried out on clinically healthy white outbred mice with a group of 10 heads with a live body weight of 12-18 g, who had not previously been exposed to toxic effects and were in the same conditions with appropriate feeding and maintenance conditions. The preparation was administered with water on an empty stomach after a 12-hour fasting diet. The feed was given 2 hours after the preparation. The animals of the experimental group received a 1% solution of potassium humate in the form of a drink freely available instead of water at a dose of 0.1 ml/0.1 l; the control group was given drinking water in similar volumes. The animals were constantly monitored. Attention was paid to behavior, motor activity, thirst, the presence or absence of appetite, the course of pregnancy (if the mice were pregnant), and other physiological parameters.

Production experiments to determine the biological effectiveness of the Gumka-KZ feed additive on the population of farm animals were carried out in farms of Akmola, Karaganda, and Pavlodar regions. Experimental and control groups of cattle were created: meat and dairy calves and crossbreed young ani-mals of 2-3 months, fattening bulls of the Kazakh white-headed breed (Akbas), and young animals of the Simmental breed. The experiment was carried out on healthy animals in the same keeping conditions of detention in a group of 10 heads weighing 100-120 kg. The selection of animals was carried out using the analog pair method. Weakened young animals with signs of metabolic disorders and clinically healthy animals were selected to participate in the experiments. The control and experimental groups of animals received the generally accepted diet. The experimental animals also received a daily preparation of potassium humate in the form of a 1% solution. We have previously selected various concentrations of potassium humate in other experiments on laboratory and agricultural ani-mals, so here is the concentration that showed the best result. The introduction of the feed additive to newborn animals was carried out once in the form of a drink of water or milk daily in the morning before feeding. The rest of the animals re-ceived the feed additive with the feed or in buckets individually with water. The use of feed additives contributed to the appearance of appetite, calves ate food with appetite, drank water and milk completely. The weight of the animals was measured before the experiment and 50 days after the first drinking of potassium humate. Visual monitoring of the condition of the animals was carried out daily, the animals were weighed monthly, and a biochemical blood test was performed before and after the experiment. The results were processed statistically.

Results

To obtain a biologically active feed additive, samples of potassium humate of Kazakh origin obtained from coals mined in Kazakhstan were analyzed by ox-idation and further ultrasonic disintegration, including the coal from the deposits of Saryadyr (1), Sarykol (2), Mamyt (3), Maikube (4), and Shubarkul (5). During the study, the absence of biological activity in sample 1 was observed. Therefore, information on this sample is not provided further.

The results of determining the organoleptic properties of four batches of potassium humate are presented in Table 1.

Table 1 – Organoleptic properties of potassium humate solutions

Indicators	Potassium humate-2	Potassium humate-3	Potassium humate-4	Potassium humate-5
Aggregate state	a thick liquid that leaves oily streaks on the walls	a liquid that leaves slight oily streaks on the walls	a thick liquid that leaves oily streaks on the walls	a thick liquid that leaves slight oily streaks on the walls
Color	brown coal	fulvous coal	fulvous coal	fulvous coal
Smell	when heated, the substance has a pronounced carbon smell/without heating, the smell is weak			
Taste	bitter	bitter	bitter	bitter
Transparency	opaque, the preparation goes off the walls of the container slowly	opaque, the preparation goes off the walls of the container quickly	opaque, the preparation goes off the walls slowly	opaque, the preparation goes off the walls relatively quickly
Sediment	insignificant	insignificant	significant	insignificant
Impurities	none	none	none	none
Foaming during shaking	forms large and small foam bubbles	forms a fine foam	forms a large foam (beer foam) and fine foam	forms a fine foam
pH	13.6	12.39	13.64	13.51

Our studies demonstrated a high biological activity of the potassium hu-mate-4 sample. The characteristics of the potassium humate of the Maykubensky deposit are given in Table 2.

Table 2 – Characteristics of potassium humate (Maykubensky deposit)

Appearance	liquid
Color	from dark brown to black
Smell	weakly expressed coal smell
Weight of dried humic acids, g/100 ml	0.237
The mass of the ash residue of humic acids, g/100 ml	0.040
Mass fraction of free humic acids per analytical state, %	54.86
Alkali concentration in liquid humic acids, g/dm3	22.6
Solubility in water, g/l	easily dissolves at 20°C
Hydrogen index, pH	11-13 units at 20°C
Density, g/cm3 at 20°C	0.96

Analysis of the IR spectra (FITR spectrum) of potassium-4 humate showed that in the spectra of humic acid, there were peaks of tension oscillations charac-teristic of hydroxyl, carboxyl, and benzene rings, and also finer molecular struc-tures (Figure 1).

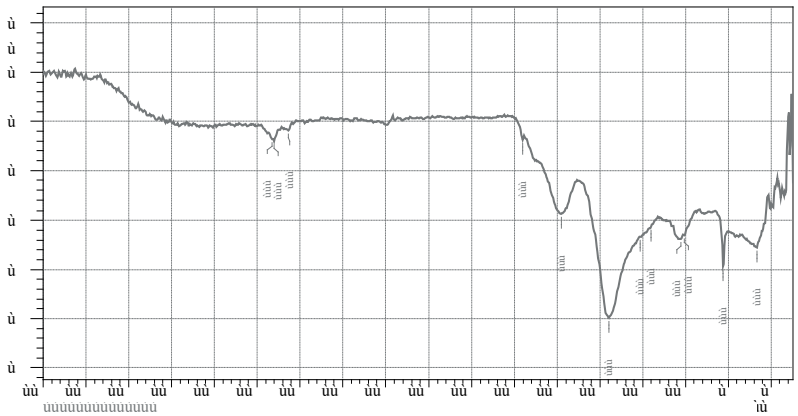


Figure 1 – IR spectra of humic acid (liquid sample of potassium humate-4)

Physico-chemical analysis of basic humate-4 showed that the preparation contained humic substances and mineral compounds and elements. Humic sub-stances in the feed additive were represented by potassium humate, humic, and fulvic acids. As additional components, the feed contained a complex of minerals (sodium (Na): 1,526 mcg/g, magnesium (Mg): 240 mcg/g, potassium (K): 10,997 mcg/g, calcium (Ca): 672 mcg/g, iron (Fe): 1,955 mcg/g, copper (Cu): 73.3 mcg/g, zinc (Zn): 3.60 mcg/g, selenium (Se): 1.16 mcg/g, and others).

The results of sterility testing of four samples of potassium humate and the finished feed additive showed that there was no growth of extraneous microflora in Petri dishes, which indicates their sterility.

Pyrogenicity tests were carried out on rabbits, not albinos, with a body weight of 2.0 to 3.5 kg. In experimental animals with an initial temperature of 37.8 and 38.1°C. Potassium humate was injected intramuscularly into the outer part of the thigh in a volume of 1.5 ml. The final body temperature of rabbits after three hours was 37 and 37.9°C, which indicates the non-pyrogenicity of the preparation.

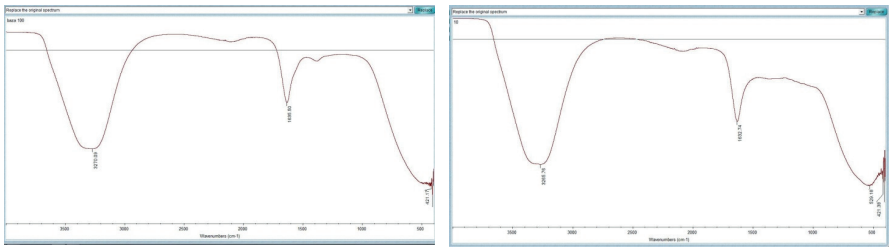
The analysis of the toxicological properties of potassium humate in differ-ent samples of the Maykubensky deposit demonstrated the low toxicity of the preparation. The toxicity and harmlessness of potassium humate were studied on white mice. Observation of animals during the experiment showed the absence of side effects in animals (no refusal of feed, weight loss, absence of case were not-ed). Thus, the sample of potassium humate-4 is sterile and harmless. According to the degree of impact on the body, potassium humate is classified as class 4 toxicity (low-hazard substances).

As a result of oral administration of 1% potassium humate solution (samples 1-4) to white mice, we additionally found that their live weight had increased slightly compared to the control group. The mice became calmer and more active, and their coat became clean and bright white. A particularly noticeable effect was noted when the mice were exposed to potassium humate from the 4th sample.

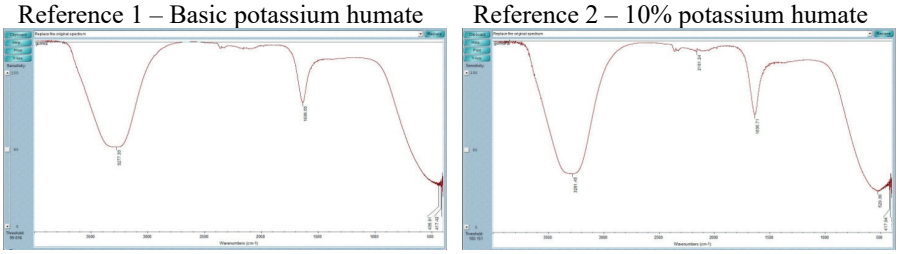
Thus, it was shown that the use of potassium humate-4 had a positive effect on the growth and development of animals and a stimulating effect on the body, which was manifested by an increase in the live weight of laboratory mice.

Based on the obtained results, we made a feed additive under the patented name Gumka-KZ. Analysis of the organoleptic properties of the finished feed ad-ditive showed that the preparation was a dark brown liquid solution with a weak specific odor, the formation of a slight sediment during storage, and a pH of 11.0±1.0.

IR spectrometry of the Gumka-KZ feed additive on the Nicolet iS 10 IR Fourier spectrometer allowed us to prove the identity of potassium humate. When comparing the reference spectra and the tested substance, it was seen that the positions of the significant bands of both spectra corresponded to each other within 0.5% of the wavenumber scale (Figure 2).



Reference 1 – Basic potassium humate | Reference 2 – 10% potassium humate



sample 1 | sample 2

Figure 2 – Comparative IR analysis of the Gumka-KZ feed additive

A comparative analysis of the IR spectra of the feed additive prototypes and control samples indicated their identity in all samples [16]. The IR spectrum of samples 1 and 2 showed that in the region of 3,300-3,000 cm-1 in the center there were wide peaks at 3,270 cm-1, which were attributed to valence bond fluc-tuations: −OH, −COOH, and H2O. The peaks at 1,637 cm-1 were attributed to the valence oscillations of the −COO group. Accordingly, this indicates at the exist-ence of oxygen-rich functional groups on the surface of pure potassium humate, which contributes to the reaction of complexation or adsorption. These peaks show fluctuations in C-O connected to the potassium ion with ion-ion interaction.

Quantitative analysis of the potassium humate content in the feed additive by UV spectrometry showed the following (Figure 3).

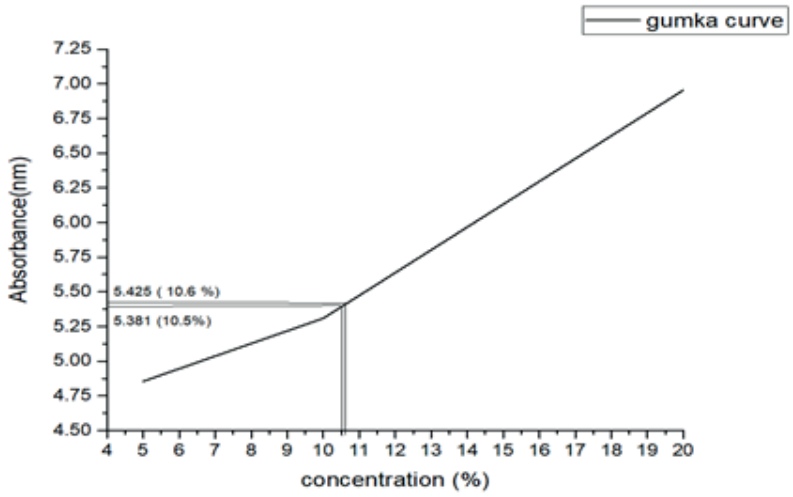


Figure 3 – Concentration of humic substances in the finished feed additive

As can be seen from Figure 3, the concentration of humic acids in two samples of the finished feed additive containing 10% potassium humate was 5.40±0.022, which corresponds to the stated indicators, since the mass fraction of free humic acids in the base solution of potassium humate was 54.86% (Table 2).

Setting up experiments to identify the effect of the Gumka-KZ feed additive based on potassium humate-4 on the growth and development of laboratory animals that received it in the form of a drink for 10 days and observation for a month showed the following: in the experimental group, the total weight increased from 46.1 to 73.7 g, and thus the weight gain was 26.6 g, while in the control group, the total weight increased from 46.5 to 65.6 g. Thus, the total weight of animals in the experimental group increased by 27.6 g, and in group 2 (control) by 19.1 g (Figure 4).

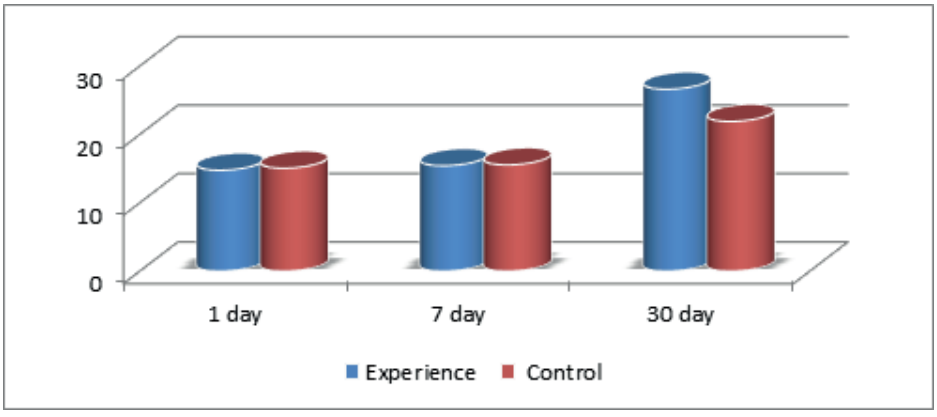


Figure 4 – Weight of laboratory animals that had received potassium humate-4 in the form of a drink

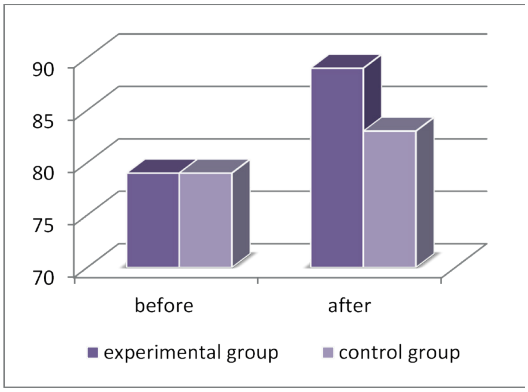
In the next stage, we studied the effectiveness of the feed additive on the population of farm animals in the farms of Akmola, Karaganda, Pavlodar, and Turkestan regions. The effectiveness of the feed additive in production experi-ments was determined on animals that had not previously been exposed to toxic effects and were in the same keeping conditions. The animals were selected by the analog pair method.

We found that the introduction of potassium humate into the calves' diet in addition to the main feed caused an improvement in metabolic processes, accompanied by an improvement in the quality of the calves' coats, increased appetite, and restoration of motor activity (Table 3).

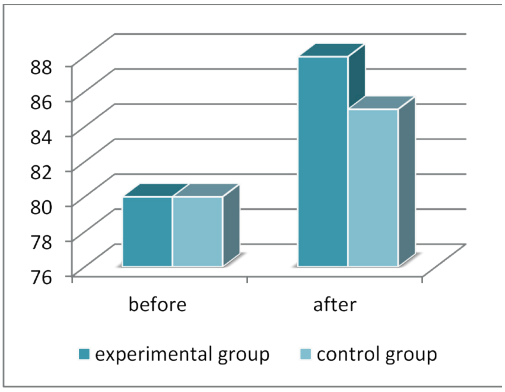
Table 3 – Analysis of comparative data on experimental animals after 30 days

Indicators	Experimental group	Control group
Appearance	healthy, the coat is shiny and bright	healthy, the coat is matte and dull
Behavior	active, mobile	calm
Water intake	within normal limits	within normal limits
Food consumption, appetite	good appetite, the animals eat greedily, within the normal limits	good appetite, the animals eat moderately, within normal limits
Shedding	30 days	47 days

The introduction of the Gumka-KZ feed additive to calves was carried out in the form of a drink with water (to healthy calves once a day and to weakened calves twice a day). The analysis of the obtained data showed the presence of a pronounced biological effectiveness of the feed additive, manifested in the in-crease in the live weight of calves of meat breeds and crossbred calves (Figure 5).



Calves of the Akbas breed, 2 months old Kadam LLP (weakened)



Calves of native breeds, 2 months old Household farm of the Arshaly village (healthy)

Figure 5 – The effect of the Gumka-KZ feed additive on the weight gain in calves

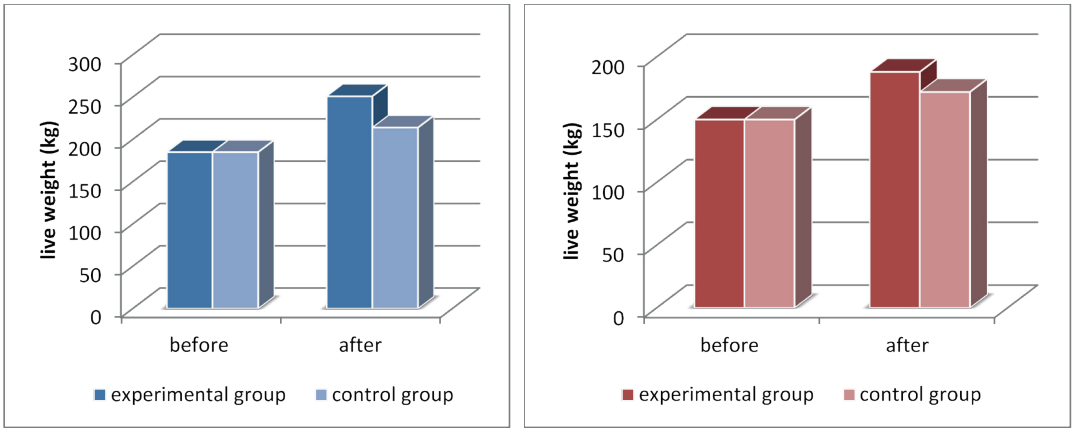
Biochemical analysis of calves' blood before and after drinking the feed additive showed the normalization of indicators to normal or average values (Table 4).

Table 4 – Effect the of feed additive on biochemical parameters of calves receiving the Gumka-KZ feed additive

Indicators	Standard	Suckling calves		Weaned calves		Fattening calves	
		Day 1	Day 30	Day 1	Day 30	Day 1	Day 30
Total protein	62,082,0	64,61±1,23	66,28±1,75	61,94±4,7	69,52±3,24	66,2±5,24	71,9±2,33
Creatinine	56-162	55,22±6,19	50,38±5,32	60,97±13,7	55,61±7,15	109,0±31,8	84,45±5,65
Total bilirubin	0,7-14,0	2,22±2,37	1,88±2,61	1,99±2,56	2,11±0,98	1,89±0,63	2,41±0,76
Cholesterol	1,3-4,42	2,34±1,16	1,97±1,43	2,37±1,08	2,16±5,16	3,75±0,64	2,88±0,33
Urea nitrogen	2,8-8,8	3,7±3,53	2,50±0,44	4,21±3,46	4,99±4,57	4,09±0,59	5,28±0,69
Glucose	2,3-4,1	2,14±0,22	2,30±0,84	2,30±0,44	2,58±0,84	0,41±0,14	1,35±0,81
Calcium	2,5-3,13	7,91±2,18	8,26±1,06	9,8±1,55	10,12±0,22	1,63±0,08	2,2±0,50
Alkaline phosphatase	18-153	298,33±5,84	199,63±2,45	166,22±7,2	155±4,85	101,04±30,76	121,35±16,52
Alanine aminotransferase (ALT)	6,9-35,0	4,67±1,71	20,10±1,41	17,33±2,56	25,33±5,41	23,10±4,36	23,29±2,66
Aspartate aminotransferase (AST)	45-110	37,50±3,74	69,54±3,44	42,69±3,71	82,50±8,77	107,30±12,9	103,22±9,15

Clinical observations have shown that on the 7th day of taking the feed ad-ditive based on potassium humate, the calves' coat obtained a noticeable shine and a bright color, and shedding was completed within a month. Clinical signs of metabolic disorders and vitamin deficiency disappeared in animals 20-30 days after they had started receiving the feed additive. Thus, we identified a positive effect of the Gumka-KZ feed additive on the metabolic processes of the bodies of farm animals.

The introduction of potassium humate into the diet of fattening animals of meat and dairy breeds, in addition to the main diet, affected the improvement of metabolic processes, which led to an increase in the live weight of fattening young animals. It was noted that the weight gain in meat animals was higher than in calves of dairy breeds (Figure 6).



Outbred calves Molshylyk-Agro Socio-Entrepreneurial Corporation (SEC) (60 heads)

Calves of the Simmental breed Milk-Product LLP (110 heads)

Figure 6 – The effect of the Gumka-KZ feed additive on the weight gain of fatten-ing young cattle

As can be seen from Figure 6, the feed additive has a pronounced biological activity, contributing to the normalization of increased weight gain in cattle.

To conduct production tests on the use of the feed additive based on potas-sium humate for fattening livestock, groups of bulls and heifers of meat and dairy cattle were formed in the Abai LLP. Out of 355 experimental bulls, 277 heads (78%) represented the Kazakh white-headed breed. Of the remaining 22%, half of the bulls represented animals born from breed transformation, and the second half were bulls of other meat and dairy cattle breeds.

The analysis of the indicators of average daily weight gain in the range of 900-1,000 g was recorded in 175 (49.3%) bulls of the experimental group. In 110 (31%) bulls, the average daily gain in live weight was in the range of 1,000-1,100 g. The average daily increase in live weight from 1,100 to 1,200 g was noted in 70 (19.7%) bulls. In the control group of 75 bulls, an average daily gain of up to 900 g was observed in 37 (49.3%). 18 (24%) bulls had a weight gain of up to 1,000 g. Up to 1,100 g of average daily gain in live weight was noted in 11 (14.6%) animals. Finally, only 9 (12%) bulls had an average daily gain of 1,200 g (Figure 7).

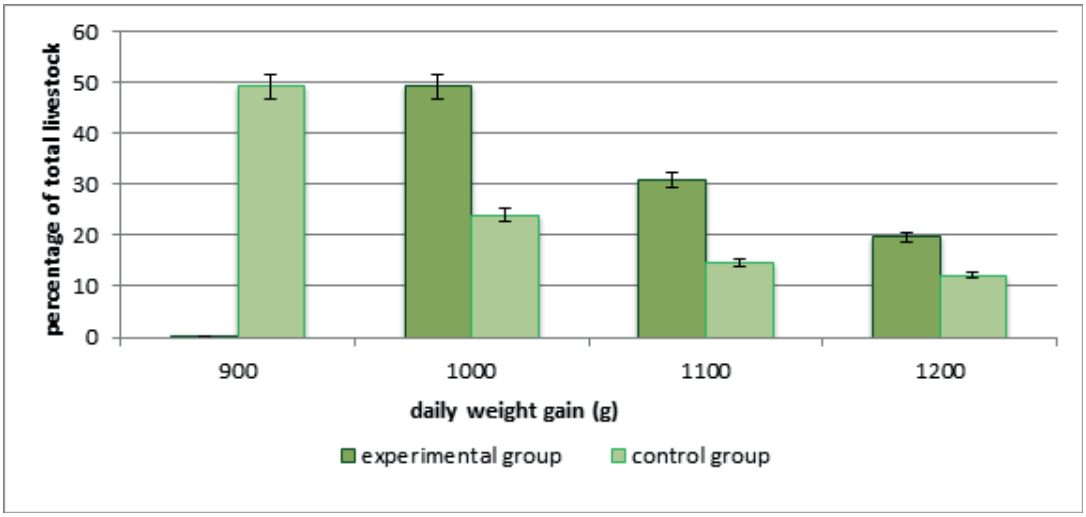


Figure 7 – Indicators of the average daily gain of fattening livestock that had re-ceived the Gumka-KZ feed additive

Comparative data show that in the experimental groups, half of the fatten-ing cattle had an average daily gain of at least 1,000 g, whereas in the control group, only half of the group reached 900 g. The same difference in quantitative and qualitative indicators was observed between the experimental and control groups in terms of average daily weight gain in live weight that equaled 1,100 and 1,200 g. Thus, we found that in the experimental group of fattening animals, the total average daily weight gain was 4-6 kg higher than in the control group. More than 50% of the bulls in the experimental group by the end of the third month of fattening gained a live weight of over 500 kg and were sent for slaugh-ter.

Discussion

In recent years, there has been an increased interest in the use of humic substances in animal diets [17-20]. Humic substances (including humic and fulvic acids) are considered safe and natural feed additives that have a beneficial effect on animal welfare and the quality of animal products. Humic substances (humic acids, fulvic acids, and humins) are natural organic substances found in the soil, formed during the humification of dead organic matter. A rich source of these compounds is oxyhumolite (oxidized brown coal) [21]. Humic acids are the main component of these substances. This fraction is insoluble in acidic solutions (pH < 2), but soluble in solutions with a higher pH. These acids have a high molecular weight from 5,000 to 10,000 Da [22]. They have many physical, chemical, and biological properties that make them suitable for use in animal husbandry and veterinary medicine. They exhibit antioxidant and anti-inflammatory effects and support the work of the gastrointestinal tract of animals, accelerating their growth and simultaneously improving

immunity and reproductive function [23].

Additives of natural origin can be added to feed to improve the growth pa-rameters, animal health, and/or improve the quality of produced meat [24]. In 1999, the European Medicines Evaluation Agency (EMEA) issued a permit for oral administration of humic acids to all animals from which animal products are obtained. In animal husbandry, the addition of humic acids to feed can positively affect all production parameters. Humates, which are part of feed or water for poultry, contribute to the growth of the birds [25].

The ability of humic acids to influence mineral metabolism in animals due to the presence of chelating properties was reported by Rybalka et al. (2020). They demonstrated the ability of humic acid to increase the content of calcium, ionized calcium, and iron, and adjust the content of copper and zinc, as well as increase the activity of alkaline phosphatase in the blood serum of rabbits. They also observed an early effect of humic acid supplementation on an increase in the content of ionized iron and calcium, as well as a later effect on the activity of al-kaline phosphatase and an increase in the content of copper in blood serum; on the distribution of calcium, phosphorus, manganese, copper, and zinc in bone tis-sue [26].

As can be seen from our results, the Gumka-KZ feed additive based on po-tassium humate of the Maykubensky deposit leads to an increase in weight gain in meat and dairy cattle, accelerates the shedding time, improves the condition of the coat, and normalizes the biochemical blood parameters. The weight gain of animals increased by 8.4% in the group of suckling calves, by 7.6% in the weaning group, and by 8.9% in the group of one-year-old calves during pasture keep-ing. Similar results on the positive effect of humic acids are described by Arif et al. (2019), who showed that humic acid plays a favorable role in increasing productivity due to its beneficial effect on the utilization and assimilation of nu-trients [9].

Conclusion

Kazakh potassium humate of the Maykubensky deposit is sterile, non-pyrogenic, non-toxic, and harmless, with an average pH of 11.0-1.0. It also has a biological effect on laboratory animals, increasing the weight of animals in the experimental group by 1.9-2.57 g per month compared to the control group of mice.

The use of the Gumka-KZ feed additive on cattle leads to an increase in weight gain, acceleration of shedding time, improvement of the condition and shiny appearance of the coat, and normalization of blood biochemical parameters. Animals become mobile and active, rumination becomes more active, the growth of animals in the experimental group is visually noticeable, and the average daily weight gain increases by 7.6-8.9%.

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