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Study on Calves' Ruminal Digesta on the Background of Extruded Forage Feeding in Combination with an Activated Water.

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ABSTRACT

Replacement of hay to 50% of his requirement with the studied extruded forage consisting of wood waste and concentrates in a diet of calves in combination with the activated water, improves cicatricle digestion, promoting increase in amount of ammoniac nitrogen, bacteria and protozoa, acetic and propionic fatty acids and decrease in oleic acid, and also increase of amylolytic and cellulolytic activity of ruminal digesta that demonstrates increase in activity of digestive processes in an organism of skilled animals in comparison with control.

Keywords: extrusion, calves, ruminal digesta.

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INTRODUCTION

The use of new forages in animal diets involves their compulsory study in terms of their negative effects on the body, and on ruminal digestion. Digestion of nutritional substances that get into the organism takes place in the cicatricle tissue. Up to 70% of the dry matter is digested here thanks to the enzymes of microorganisms contained in the cicatricle tissue. Enzymes of microorganisms absorb non-protein nitrogen; break down high molecular weight protein and complex carbohydrates that are further used by the body for energy production. They also form vitamins of group B and K [1,2]. Protein splitting occurs due to the proteolytic enzymes of microorganisms with the formation of amino acids at first stage and ammonia after the process of deamination [3,4]. Cellulose and starch under amylolytic and cellulolytic enzymes influence fall apart at first to di - and monosaccharides, and then to carbon dioxide, volatile fatty acids (volatile fatty acids), non-volatile fatty acids and gases [5,6]. Forage fats split to high-molecular fatty acids, such as oleic, linoleic and others under the action of lipolytic enzymes [7]. In addition, it should be noted that after dying microorganisms split in the rennet and intestine thus giving their owner – ruminant animal – food which has a high value [8,9].

The diet with easily digestible carbohydrates is essential for the cicatricle tissue microorganisms normal functioning. The task was set to use new extruded feed concentrate when feeding calves in combination with the activated water and to investigate its influence. All methods of water activation can be divided into specific and non-specific. Specific methods of water activation include small doses of various substances to water. In non-specific methods the water is exposed to any influence, for example, a magnetic field, radiation [10,11]. Non-specific method of water activation based on the mechanical method of activated water preparation by UDA technologies was used in our research [12]. This technology is based on three main processes: dispersion (grinding), exposure to high temperature and catalysis. Substances in a special technological setup UDA (universal disintegrator-activator) are activated by means of powerful mechanical energy. Thanks to the improvement, a technological unit RDS-1 was created, which allowed to obtain more stable activated water.

The lack of harm of the studied extruded forage on the laboratory animals was proved in preliminary experiments [13]. The zootechnical analysis of the studied forage showed that the technological processing of the forage mixture brought the nutritional value of the extruded coarse forage closer to the sowing hay in such substances as crude protein, crude fat, crude fiber and sugar [14]. The purpose of our experiment is the hay partial replacement for the ruminants. So the aim of this work was to study its effect on calves' cicatricle digestion in combination with the activated water in animals' watering.

MATERIALS AND METHODS

The study of the extruded coarse forage influence in combination with activated water on the calves aged from 30 days to six months was conducted in LLC AF 'Kukmara' in Kukmor district of the Tatarstan Republic. The Kholmogorskaya breed animals of the Tatarstan type were divided into three groups of 10 animals each. Experimental and control groups were formed on the principle of analogues.

Calves were kept in rooms of light construction, in group cages on 5 heads. The parameters of the microclimate were within the limits of hygienic norms (table 1).

Table 1: Main Parameters of the Microclimate in the Calf-herd

Indicators	Period of Study, by months of the experiment				
	1	2	3	4	5
Temperature, °C	12.8±0.6	12.0±0.7	8.7±0.5	7.3±1.2	8.1±0.5
Humidity, %	70.9±3.6	74.1±3.8	73.9±3.7	70.4±3.6	72.1±4.1
Air velocity, m/s	0.12±0.01	0.15±0.02	0.19±0.02	0.16±0.02	0.19±0.02
Concentration NH_3, mg/m^3	6.7±0.3	7.1±0.5	7.4±0.5	7.5±0.4	8.2±0.5
Concentration H_2S, mg/m^3	0.01± 0.001	0.01± 0.001	0.02± 0.001	0.02± 0.001	0.02± 0.001
Concentration CO_2, mg/m^3	0.09± 0.001	0.09± 0.001	0.10± 0.004	0.11± 0.002	0.10± 0.003

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Illumination, lux	60.2±3.4	59.1±3.5	62.3±3.8	63.1±3.5	65.1±3.2
Noise level, Decibell.	42.5±2.1	52.1±2.7	53.2±2.6	52.7±2.7	54.2±2.8
Dust concentration, mg/m^3	0.21±0.01	0.23±0.02	0.22±0.01	0.24±0.02	0.27±0.02
Microbial bodies, thousand/m^3	27.8±1.4	28.2±1.5	28.7±1.6	29.2±1.6	29.8±1.4

Experimental calves' feeding was carried out according to the generally accepted norms (Kalashnikov, A.P., et al., 2003, 143-149) according to the following scheme:

Group 1 (control) – the basic economic diet given to calves according to the feeding scheme depending on their age;
Group 2 (experimental) – 50% of hay was replaced with the studied extruded coarse forage;
Group 3 (experimental) – 50% of hay was replaced with the studied extruded coarse forage, and activated water was used for animals' drinking.

Wood wastes (70%) in combination with a small amount of grain cereal (30% barley) were used for the preparation of the forage. They were subjected to incremental processing. Multienzyme 'NIST' was used at the beginning of the fermentation at the rate of 1.5 kg per 1 ton of the mixture at a temperature of 50-55°C. Mechanoactivation in the disintegrator followed next. Extrusion at a temperature of 110-160°C and a pressure of 40-80 atm. was done in a final stage.

In addition, our task was to study the possibility of using extruded coarse forage in combination with the activated water obtained in the RDS-1 activator where it changes its properties under the influence of a sharp change in the speed and direction of movement. Thus, the solubility of various substances in it increases.

The concentration of metabolites in ruminal digesta was observed to study the intensity of metabolic processes in the experimental animals' organisms at the end of the experiment. Samples of the cicatricle chyme were taken from 3 animals in each group with the help of a food probe one hour before and one and three hours after the morning feeding. The content of ammonium nitrogen by means of the microdiffusion method in Conway's cups, the number of microorganisms counted in the Goryaev's camera, total concentration of volatile fatty acids and their ratios obtained by distillation in the Markham's apparatus with subsequent stripping in a gas chromatograph (Chrome-42 and the Color-800), amylolytic and cellulolytic activities [15]; hydrogen ions concentration (pH) on pH meter LPU-0.1 were determined in the samples of cicatricle chyme.

All the experimental calves responded adequately to external stimuli during the entire experimental period. Food excitability was within the physiological norm; the tested animals of the second and the third groups were eating the observed forage with a big appetite as it acquires the taste and smell of the freshly baked bread.

RESULTS AND DISCUSSION

The research was conducted on calves aged from 30 days to six months. Experiment ruminal digesta were studied in experimental animals after five months. The results are presented in Table 2.

Table 2: Individual Indicators of Ruminal Digesta

Indicator		Group		
		the first	the second	the third
		1 hour before feeding		
pH		6.71±0.34	6.67±0.33	6.59±0.31
Ammonia, mg/100 ml		10.9±0.5	11.0±0.5	11.3±0.6
Volatile fatty acids, mmol /100 ml	acetic	4.15±0.12	4.16±0.11	4.21±0.13
	propionic	0.92±0.04	0.93±0.04	0.95±0.05
	oleic	0.87±0.05	0.86±0.04	0.84±0.04
Total number of bacteria, bn / ml		7.87±0.38	7.92±0.41	8.12±0.48

Ciliates number, thousand/ml		189±9	191±11	195±12
Activity, u / ml	Amylolytic	20.5±1.0	20.7±1.1	21.1±1.2
	Cellulolytic	11.3±0.5	11.4±0.5	11.6 ±0.6
		1 hour after feeding		
pH		5.95±0.31	5.84±0.29	5.81±0.30
Ammonia, mg/100 ml		13.2±0.6	13.4±0.7	13.9±0.8
Volatile fatty acids, mmol /100 ml	acetic	4.58±0.23	4.63±0.24	4.72±0.25*
	propionic	0.96±0.05	0.97±0.05	1.00±0.06
	oleic	0.95±0.05	0.94±0.05	0.92±0.04
The number of ciliates, bn/ml		7.74±0.38	7.78±0.39	7.94±0.43
Total number of bacteria, bn / ml		191±10	193±10	195±11
Activity, u / ml	Amylolytic	20.7±1.0	20.9±1.1	21.3±1.1
	Cellulolytic	11.5±0.5	11.6±0.9	11.8 ±0.8
		3 hours after feeding		
pH		6.29±0.29	6.21±0.31	6.17±0.32
Ammonia, mg/100 ml		11.4±0.6	11.5±0.6	11.9±0.7
Volatile fatty acids, mmol /100 ml	acetic	4.37±0.22	4.41±0.23	4.47±0.24*
	propionic	1.01±0.05	1.02±0.05	1.04±0.06
	oleic	0.98±0.05	0.97±0.05	0.96±0.04
Total number of bacteria, bn / ml		7.68±0.37	7.72±0.39	8.87±0.42
Ciliates number, thousand/ml		185±9	187±15	189±13
Activity, u / ml	Amylolytic	20.6±1.1	20.8±1.1	21.1±1.2
	Cellulolytic	11.4±0.6	11.5±0.7	11.7 ±0.7

Analyzing the data obtained at the end of the experiment it should be noted that all calves' ruminal digesta had a slightly alkaline or neutral pH before feeding. After feeding it turned into slightly acidic pH which is caused by more intense fermentation and the formation of metabolites after tested animals feeding.

The amount of ammonia nitrogen in the second group of experimental calves (replacement of 50% of hay with the studied extruded coarse forage) was 1.5% higher in comparison with the control group one hour later after feeding. The combination of the extruded coarse forage with the activated water (the third group) contributes to an increase of 5.3%, three hours after feeding. These data were 0.9 and 4.3%, respectively. The results obtained during the study indicate an increase in protein metabolism in the calves' bodies in the experimental groups which is consistent with a large gain in live weight compared to control [16].

The amount of volatile fatty acids increased in the second group of experimental calves compared to the control group. So acetic acid increased by 1.1% and propionic acid increased by 1.0%, and oleic, on the contrary, decreased by 1.1%. For the third group of experimental calves these data were 3.1, 4.1 and 3.3% respectively. The quantity of volatile fatty acids increased compared to the previous figures three hours later after the feeding. Their content was higher in experimental groups compared to the control, so the amount of acetic acid was higher by 0.9% and propionic by 1.0%, and oleic, in contrast, less than 0.9%. The numbers were 2.3, 3.0, and 2.1% respectively for the third group of the experimental animals. Apparently, this is due to the splitting of high-molecular forage compounds. It leads to an increase in low-molecular compounds under the influence of phased processing, namely, pre-fermentation, disintegration and subsequent extrusion of the forage under study. The increase of low molecular weight compounds has a positive effect on the feed fermentation activation with the rumen enzymes. This process is enhanced by calves watering with the activated water. It contributes to the feed ingredients better solubility.

Bacteria and protozoa number increased by 0.6 in the experimental groups one hour later after feeding and 1.0% compared to the control in the second group and 2.6 and 2.1% in the third group. Three hours after feeding it was 0.5 and 1.0% and 2.5 and 2.1% respectively.

Amylolitic and cellulolytic activity of the ruminal digesta in experimental calves of the second group was higher compared to the control group one hour later after feeding at 1.0 and 0.9% and for the third group it made 2.9 and 2.6%. Three hours later after feeding the numbers were 0.9 and 0.8%, and 2.4 and 1.8% respectively which is probably due to the crude cellulose splitting to di- and monosaccharides which are more

accessible to the microflora of the ruminal digesta during pre-fermentation of the studied forage, as well as at the further disintegration and extrusion.

The positive use of the activated water in the experimental animals' drinking of the third group should also be noted. It improves feed nutrients solubility and is associated with an increase in the amount of energy in water clusters during its treatment in the RDS-1 activator.

CONCLUSION

According to the data obtained during the experiment, it can be concluded that 50% of the hay replacement by the extruded forage in the calves' diet does not have a negative impact on their body. In combination with the activated water it improves ruminal digesta which is expressed in an increase in the amount of ammonia nitrogen, bacteria and protozoa, acetic and propionic fatty acids and a decrease in oleic acid. An increase in amylolytic and cellulolytic activity of the ruminal digesta indicates an increase in digestive processes of experimental animals' group compared to the control one.

The positive results obtained during the experiment are likely to be associated with the forage mixture phased processing at the beginning of fermentation, multienzyme preparation, mechanoactivation in the disintegrator and the extrusion in a final stage. Fermentation with a polyenzyme allows to split high-molecular compounds to low molecular ones. Mechanoactivation process of the tested forage components in the disintegrator promotes grinding, homogenization and further increase in the reactivity with the enzymes. Extrusion exposes the forage mixture components to high pressure and temperature. There is a further splitting of the foraged ingredients as a result of this treatment. It contributes to final product taste improvement, since various aromatic substances are formed, and the final product in its composition corresponds to the hay.

The water used in the experimental animals' drinking is activated in the RDS-1 activator. A sharp change in the speed and direction of the flow along with its turbulization can improve the efficiency of various substances dissolution and reduce the size of the droplets in the resulting emulsion. The increase in the number of energy-loaded impacts per unit of time together with the water clusters grinding by the working bodies of RDS-1 also contributes to a faster and better dissolution of nutrients when watering calves with activated water. It improves their digestibility in the animals' bodies.

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