PROBIOTIC AND PREBIOTIC INFLUENCE ON HEMATOLOGICAL VALUES OF GOAT KIDS

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Abstract
Blood haematology is one of the indicators that shows if a goat (*Capra hircus)* kid gets a sufficient quantity of liquid, has a good supply of oxygen in the body, as well as an indication of inflammatory processes. Our aim of this research was to find out how feed additives (probiotics (*Enterococcus faecium*), prebiotics (Jerusalem artichoke (*Helianthus tuberosus L.*)) and symbiotics (*Enterococcus faecium* + Jerusalem artichoke)) influence on haematological parameters of kids. Research was performed in Latvia in 2014. The blood samples were analyzed for leucocytes (WBC), erythrocyte number (RBC), haemoglobin (HGB) concentration, packed cell volume (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentrations (MCHC). Since the blood indicators have not significantly changed in all examination times, we analyzed the results of the age of 4, 8 and 12 weeks. HCT downward trend in blood sampleMRG + PRO, MRG + PRE and MRG + SIM group of kids was observed from the fourth week up to the eighth week and then it gradually increased. The results showed that the HCT, HGB, RBC, MCHC and WBC number was comparable ($p>0.05$) between groups. Our results prove that the use of Jerusalem artichoke powder as an additive to food not only improves digestion and metabolism of ruminant, but also helps to maintain constant haematological values. In the control group and the kids who received probiotics, prebiotics or symbiotics - significant differences are evident in all hematological parameters ($p<0.05$) at the age of 12 weeks.
Key words: goat kid, haematology, probiotic, prebiotic, symbiotic.

Introduction

Latvian goat (*Capra hircus)* industry increases every year. There are two main directions of use - dairy goats and meat goats. Health of animals is very important to increase productivity. Blood haematology is one of the indicators that shows if a kid gets a sufficient quantity of liquid, has a good supply of oxygen in the body, as well as it is an indication of inflammatory processes. There are very few studies about the haematological values in goat kids.

Jerusalem artichoke (*Helianthus tuberosus*) is mostly grown to produce tubers that are further processed and used as diabetic sweeteners and prebiotics. The inulin content of the tubers amounts to 340 mg g^{-1} DM (dry matter). Typically, Jerusalem artichoke flour contains inulin on average 10 g kg^{-1}(%), while the specially developed technology allows to increase the amount of insulin to 48.5 g kg^{-1}(%) - 50.1 g kg^{-1}(%) (Fleming et al., 1979; Hindrichsen et al., 2004; Ārne et al., 2014; Inchuen et al., 2014). Extracts from Jerusalem artichoke tubers have great potential as additives to animal feed due to their bifidogenic effect. The addition of Jerusalem artichoke tuber extracts to diets, for instance, could lead to feed efficiency improvements, improved digestion and reductions in diarrhea (Stanley et al., 2008). Probiotic supplements contain viable bacteria (e.g., *bifidobacteria, enterococcus* and *lactobacilli*) designed to shift the balance of the microflora in the large intestines to the detriment pathogenic bacteria. J.T. Huber (1997) considers that probiotics reduce digestive disturbances, increase weight gain, and increase milk production of dairy cattle (Huber, 1997). Probiotics can contain prebiotics as substrates and then they are called symbiotics (Stanley et al., 2008). T.J. Bunce et al. and E.A. Flickinger consider that symbiotics increase bifidobacteria populations in the colon and may protect against pathogenic *E. coli* (Bunce et al., 1995; Flickinger et al., 2003).

Our aim was to find out how feed additives (probiotics and prebiotics) influence the kid haematological parameters, because these parameters are one of the health status indicators.

Materials and Methods

Research was performed in a farm of Latvia, Zemgale region, from February to April, 2014.

In total, 40 Saanen goat kids were involved in the research. All kids were kept with mothers for two weeks and then separated. Each group was assembled from goat kids of both sexes (n = 10) at of aged 14±2 days. After age of two weeks kids were fed with foregoing calf milk replacer using nipple buckets and lived separately from mothers in a cote. We formed 4 groups for the research. The control group (MRG+C) kids (n=10), probiotic group (MRG+PRO) where kids with milk replacer additionally received *Enterococcus faecium* 0.025 g day^{-1} (n=10), prebiotic group (MRG+PRE) where kids with milk replacer additionally received powder of Jerusalem artichoke (*Helianthus tuberosus L.*) 0.04 g day^{-1} with increased insulin concentrations in flour (n=10), symbiotic group (MRG+SIM) - where kids with milk replacer additionally received *Enterococcus faecium* plus powder of Jerusalem artichoke (n=10).

Drinking water and hay were easy accessible all the time.

The animals were apparently healthy. At the age of two weeks blood analysis of all animals was examined and physiological parameters (heart rate, respiratory rate, temperature) were assessed. In week 4, 8, and 12 we collected blood samples (6 mL) by jugular venapuncture in ethylene diamine tetracetate (EDTA) vacutainer tubes and transported to the laboratory for analysis. The samples were analyzed within two hours after collection. The samples were collected in the morning - two hours after feeding. The blood samples were analyzed for leucocytes (WBC) and erythrocyte (RBC) number, haemoglobin (HGB) concentration, packed cell volume PCV (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentrations (MCHC) measured by automatic analyzer Mindray BC 2800Vet (Schlamet al., 1975; Egbe-Nwiyi, 2000; Iriadam, 2007; Jawasreh et al., 2009; Elitok, 2012). We investigated the samples in morfofunctional laboratory at Latvian University of Agriculture in Faculty of Veterinary Medicine.

The data obtained in the research were statistically processed by using R Studio programme. Mean arithmetic value and the standard error were calculated.

Results and Discussion

Blood haematological values can vary depending on age, gender, goat breed, environmental temperature, feeding type and health status (Daramola et al., 2005; Elitok, 2012). In this study, we wanted to find Jerusalem artichoke concentrate and probiotics *Enterococcus faecium* impact on kid blood haematological values.

Analyzing the results of WBC (Fig. 1), the largest increase in the number of white blood cells is observed directly in MRG + C 15.5 ± 2.90 x$10^{9}L^{-1}$ group of kids, while in MRG + PRO the values are decreasing. The similar trend of WBC was established in the reports of other studies (Daramola et al., 2005; Piccione et al., 2010). From the age of 8 weeks WBC number in MRG+PRO, MRG+SIM and MRG+C decreases and it refers to more stable state of health. Increased WBC number is in response to inflammation or infection diseases or it may also be attributed to physiological phenomena - excitement or strenuous exercise during handling (Daramola et al., 2005; Zamfirescu et al., 2009). We observed that the physiological indicators ranging from 8 weeks became more stable. The most significant changes were observed at the age of 12 weeks. WBC number in MRG+C was significantly higher than in MRG+PRO, MRG+PRE and MRG+SIM ($p<0.05$) ones.

There are studies, in which it is found out that the number of erythrocytes gradually increases, especially in the first three months of life, and reaching the age of 6-9 months, RBC does not change significantly (Egbe-Nwiyi, 2000). In our study, this trend was observed only in MRG+PRE group (Fig. 2). The values ranged from 11.3 ± 1.29 x$10^{12}L^{-1}$ to 14.1 ± 2.17 x$10^{12}L^{-1}$. Also, RBC growth in MRG+PRE kids is observed throughout the study period. In MRG+ C group RBC values decreased from 12.6±1.81 x$10^{12}L^{-1}$ on week 8 till 10.7±0.73 x$10^{12}L^{-1}$ by the end of the research ($p< 0.5$).

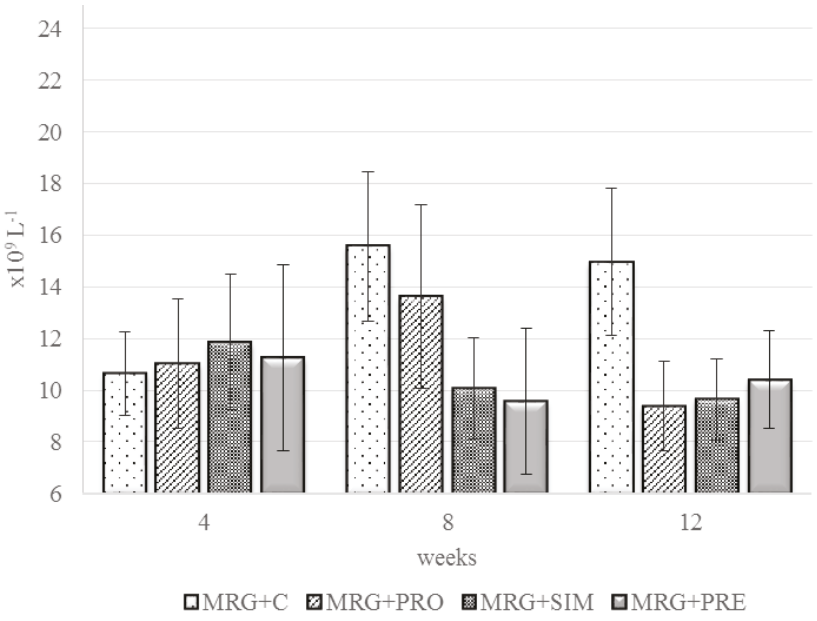

Figure 1. Goat kid leukocyte (WBC) value changes depending on the type of feeding in the first three months of life.

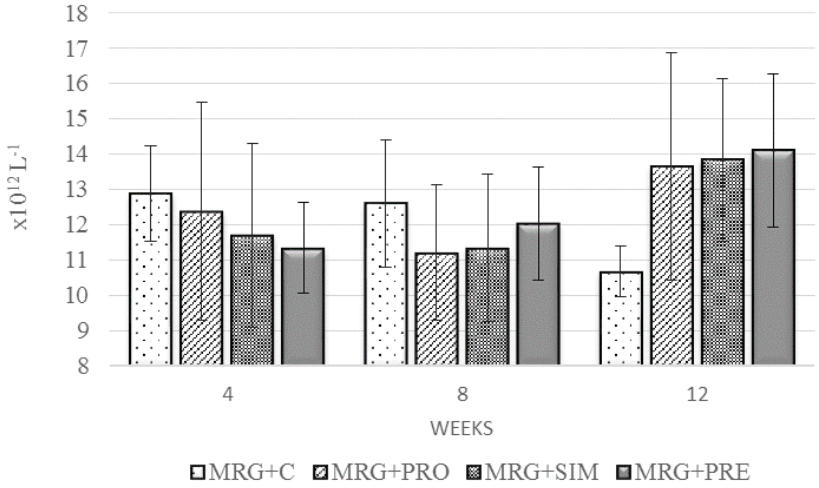

Figure 2. Goat kid Erythrocyte (RBC) value changes depending on the type of feeding in the first three months of life.

Haemoglobin in the kid blood tests is displayed in Figure 3. HGB concentration in all groups fed with additives decreased till the end of the second month and then gradually increased by the end of the research. High HGB values are an advantage in terms of the oxygen carrying capacity of the blood (Daramola et al., 2005). The highest haemoglobin of 8.9 ± 0.71 g dL^{-1} in MRG + C group kids was observed on the fourth week and then it gradually decreased to 6.0 ± 0.65 g dL^{-1} at the age of 12 weeks.

HCT downward trend in blood samples (Fig. 4) in MRG + PRO, MRG + PRE and MRG + SIM groups of kids was observed from the fourth week up to the eighth week, and then it gradually increased. HCT-level of MRG + C kids was falling in the whole research period. In the fourth week HCT was 28.9 ± 2.82% and fell to 18 ± 2.3% at the end of the research. At the age of 8 weeks HCT level in all groups was decreasing below the normal value (22-38%), MRG+PRE was 21.9±2.90%, MRG+C 20.6±3.03% and then increased by the end of the research (Porter et al., 2011; Pugh et al., 2012). There are findings that HCT value varies from breed to breed in goats. Also, J.O. Daramola et al has described that the increase of HCT values in cattle is related to the increase of environmental temperature and this coincides with our findings, since in the course of our investigations the air temperature dropped sharply in mid-March compared to February (Daramola et al., 2005).

Erythrocyte parameters – MCV, MCH and MCHC values in all involved groups are shown below in Table 1. The remaining differences between the groups are

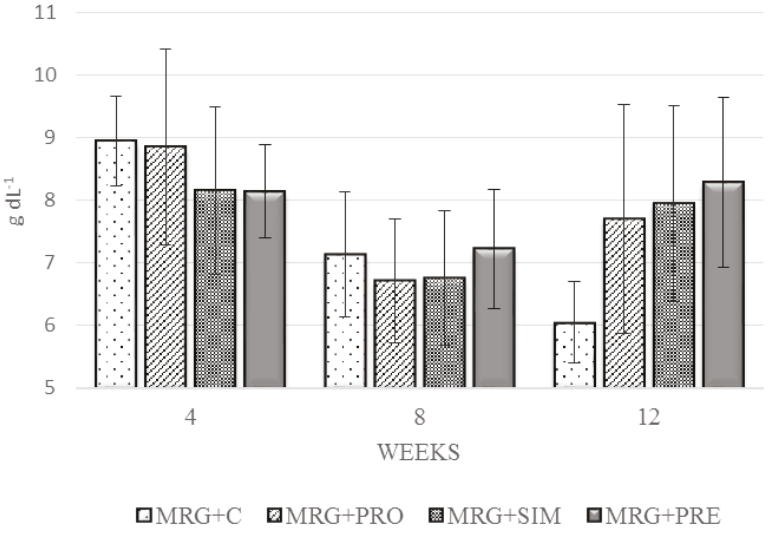

Figure 3. Goat kid haemoglobin (HGB) value changes depending on the type of feeding in the first three months of life.

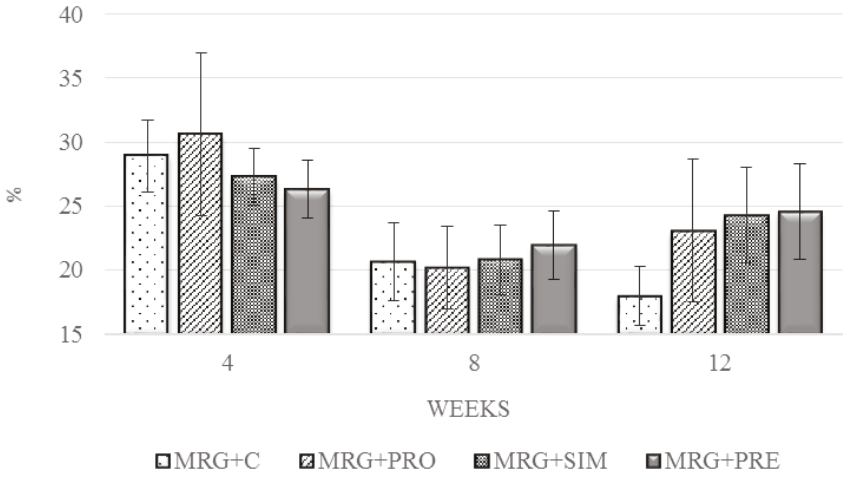

Figure 4. Goat kid packed cell volume (HCT) changes depending on the type of feeding in the first three months of life.

not so significant to evaluate. MCV and MCH amount for all groups during the study dropped alike. At baseline, the amount of MCV in groups ranged from 22.7±2.63 to 25.4±4.78 fl, while at the end of the experiment from 16.1±1 to 1.5± 0.79 fl.

Probiotics, prebiotics or symbiotic additives did not show significant differences between the experimental groups. MCH values between the groups ranged from 6.9 ± 1.54 pg to 7.3 ± 1.54 pg in the fourth week and from 5.6 ± 0.21 pg to 5.8 ± 0.19 pg at the end of the study ($p > 0.05$).

MCHC value gradually increasing trend was observed in MRG + PRE group of kids. In MRG + SIM group the increase was observed up to the age of 12 weeks. The MCHC value decline in MRG + PRO kids was observed from the second to the fourth week, from 30.1 ± 0.85 g dL^{-1} to 29.2 ± 2.73 g dL^{-1}. Till the end of the research MCHC value was increasing.

The results showed that the HCT (PCV), HGB, RBC, MCHC and WBC number was comparable ($p<0.05$) and this coincides with the studies of other authors (Iridiam, 2004; Daramola et al., 2005; Zamfirescu et al., 2009; Shaikat et al., 2013).

Evaluating the above presented results of MCV, MCH and MCHC, it can be observed that haematological parameter values of the control group kids are lower than in other groups. This indicates that probiotics and prebiotics have a positive effect on the digestibility of feed intake and absorption ability of the kid in the body, thus improving blood haematology.

Table 1

Erythrocyte parameters [mean ± S.D] of goat kids which were fed by milk replacer with probiotic or/and prebiotic and kids which were fed by mother milk

Age weeks	MRG+C		MRG+PRO		MRG+PRE		MRG+SIM	
	mean	stdev	mean	stdev	mean	stdev	mean	stdev
MCV fl								
4	22.7	2.63	25.4	4.78	23.3	1.55	24.2	4.07
8	16.4	0.40	18.2	2.42	18.3	0.81	18.5	1.84
12	16.8	1	16.9	0.90	17.4	0.79	17.3	1.43
MCH pg								
4	6.9	0.56	7.3	1.54	7.1	0.30	7.1	1.04
8	5.6	0.18	5.9	0.54	5.9	0.16	5.9	0.41
12	5.6	0.21	5.5	0.21	5.8	0.19	5.6	0.23
MCHC g dL^{-1}								
4	30.9	1.22	29.1	2.73	30.8	0.96	29.8	0.66
8	34.5	0.42	33.3	1.50	32.8	0.92	32.5	1.42
12	33.6	0.65	33.0	1.30	33.6	0.91	33.0	1.71

MCV - mean corpuscular volume, MCH - mean corpuscular haemoglobin, MCHC - mean corpuscular haemoglobin concentrations.

Conclusions

Our results prove that the use of Jerusalem artichoke powder as an additive to food helps to maintain constant haematological values. In the control group and the group where kids received probiotics, prebiotics or symbiotics - significant differences are evident at the age of 12 weeks in all haematological parameters ($p>0.05$).

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