Advances in Dairy Research

Bagnicka et al., J Adv Dairy Res 2014, 2:2
http://dx.doi.org/10.4172/2329-888X.1000123

Research Article | Open Access

Active Dry Yeast Culture Supplementation Effect on the Blood Biochemical Indicators of Dairy Goats

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Received date: August 25, 2014, **Accepted date:** September 02, 2014, **Published date:** September 10, 2014

Abstract

The aim of study was to assess the feeding level on a commercial farm and to evaluate the effect of active dry yeast culture supplementation on blood indicators of dairy goats. Eighteen goats were divided into control and experimental groups. Beginning one week before expected kidding does in experimental group were supplemented 10 g/day/goat of yeast until 100d post-partum, after which the dose was increased to 20 g/day/goat. Blood samples were taken on days 7, 30, 80, 120 and 180 of lactation.

There were differences in AST and ALT activity, and ALB, total protein, and creatinine contents between groups on the 180th day of lactation. The parameters of lipid and bone profiles changed concurrently/in parallel in both groups and differences between the groups were found only in calcium and total protein contents at the end of the experiment. The level of creatinine kinase was higher than the upper limit of reference value in both groups. In the experimental group there were no differences in macroelement contents during lactation. In the control group the contents of most macroelements were lowest on 180th day of lactation.

Some biochemical indicators had values below references (glucose, AST, ALT GGT LDH, calcium, total protein), which means that the diet of the animals was not properly balanced or may be because of a malnutrition problem. However, the values in the experimental group underwent much lower fluctuations, and thus the yeast supplementation could have had a positive influence on the homeostasis and could have improved the intestinal absorption of minerals.

Keywords: Dairy goat; Blood serum; Biochemical indicator

Introduction

Yeast cultures usually contain the living yeast cells of *Saccharomyces cerevisiae* in concentrations of at least 10 billion colonies per gram [1]. They have been recently used as a probiotic in the diets of ruminants to create a more advantageous rumen environment for anaerobic, cellulolytic bacteria, and to support their growth and activity [2]. Optimum milk yield and good animal health depend on stabilization of the rumen environment [3]. Our earlier findings indicated an influence of living yeast diet supplementation on increased expression of genes encoding the antimicrobial peptides β2-defensin, bactenecin7.5 and hepcidin in goat milk somatic cells. Therefore, this might confirm the role of this food additive in maintaining the health status of the goat mammary gland [4].

Strusińska et al. [5] found a positive influence of yeast, mineral and vitamin supplementation of dairy cows' diet on some biochemical blood parameters, but the results obtained by Nursoy and Baytok [6] contradict these finding. Doležal et al. [3], when they fed high yielding dairy cows with total mixed ratio (TMR) supplemented by yeast culture, obtained higher concentration of glucose, calcium, phosphorus, copper, zinc, magnesium, and AST and lower urea level in blood serum than in control group. However, the activity of alanine transaminase (AST) and lactate dehydrogenase (LDH) enzymes did not exceed the definite reference value for cows. The study of Kowalik et al. [2] showed decreased concentrations of total protein, triacylglycerol and total cholesterol in heifers' blood serum when live yeast cell additive was introduced to the diet, compared to animals fed a control diet or metabolites of yeasts.

Diagnostic results of biochemical analysis of serum provide information on the function of almost all organs, the state of hydration and nutrition, and disease progression, and can also help to detect subclinical metabolic disorders [7] caused by nutrition mistakes. Moreover, there is limited information concerning goat yeast supplementation. Therefore, the aim of the study was to assess the feeding level on a commercial farm and to evaluate the effect of active dry yeast culture supplementation (*Saccharomyces cerevisiae*) on selected blood indicators of dairy goats.

Material and Methods

The study was conducted on 18 Polish White Improved (PWI) and Polish Fawn Improved (PFI) dairy goats maintained in a typical commercial herd of 50 goats under milking control. The average daily milk yield in the herd during the ca. day 270 of the lactation was about 2.5 kg (SD=0.5) per day, with 3.50% (SD=1.0) of fat and 3.00% (SD=0.3) of total protein. The goats were kept in a barn with free style design and milked mechanically twice a day. All the animals were negative from the CAE virus. The goats were between the second and fifth lactation. Two analogous groups of goats, according to age and breed, were divided into two groups (N=9 in each of them). Each group consisted of 5 PWI and 4 PFI goats. Four of them (2-PWI and 2-PFI) were in their second lactation, and the other five (3-WPI and 2-PFI) in more than their second lactation.

The basic diet consisted of corn silage and concentrates, supplemented with a mineral and vitamin mixture: VITAMIX KW (Polmass, Poland). During the spring and summer the goats had approach to a grassy catwalk. Water was available ad libitum. The animals were fed a routine diet that had been used in this herd for many years. Additionally, the experimental group was given active dry yeasts to check its influence under the conditions of an average commercial herd. The control group was fed with the basic diet while the diet of the experimental group was supplemented with 10 g/day/goat of Saccharomyces cerevisiae active dry yeast culture (YeaSacc®1026, Alltech®) from one week before kidding to day 100 of lactation, after which the dose was increased to 20 g/day/goat. To eliminate the influence of the stage of lactation and milk yield (metabolic rate) on the parameters studied, blood samples were taken on days 7, 30, 80, 120 and 180 of lactation.

The serum samples were examined according to biochemical parameters using INTEGRA (Roche, Switzerland) apparatus. To establish the activity of organs important for the functioning of organisms, the biochemical parameters in the blood serum of the goats were analyzed as follows:

- liver profile, with analysis of glucose, aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma-glutamyl transferase (GGT), lactate dehydrogenase (LDH), albumins (ALB), total cholesterol (TCHOL), low density cholesterol (LDL), high density cholesterol (HDL) contents, bilirubin;
- lipid profile with analysis of total cholesterol (TCHOL) and triglyceride (TRIG) contents;
- bone profile with analysis of calcium (Ca), phosphorus (P), total protein (TP) and albumins (ALB) contents;
- kidney profile with analysis of creatinine (CRE) content and creatinine kinase (CK) activity.

Moreover, contents of chloride (Cl), iron (Fe), potassium (K), magnesium (Mg), sodium (Na) and lipase in blood serum were estimated.

All traits were tested for normality of distribution. Analysis of variance was conducted with Student's t-test or the Tukey-Kramer test (SAS/STAT) [8] to check the influence of yeast supplementation and other effects, such as goat breed, parity, and stage of lactation on the blood indicators of dairy goats. The following statistical model was used:

$$y_{ijklm} = \alpha + (YS^{*}SL)_{ij} + BR_k + P_l + e_{ijklm}$$

Where, y_{ijklm}- trait value, α- overall mean, $(YS^{*}SL)_{ij}$- fixed effect of interaction between i-th yeast supplementation and j-th stage of lactation (i=1,2; j=1,…,5), BR_k– fixed effect of j-th goat breed (j=1,2), P_l– fixed effect of k-th parity (k=1,2), e_{ijklm}– random error.

Results and Discussion

The breed and parity did not influence the biochemical parameters in blood serum of the goats during entire lactation (data not shown).

The indicators of liver profile are shown in table 1. One of the most important carbohydrates is glucose. This monosaccharide is the fundamental energetic substrate of living organisms. Its main source is food (saccharose, starch), reserves of glycogen in the liver, and synthesis reactions. In humans, increase in glucose concentration is caused by diabetes, disorders in glucose tolerance, Cushing's syndrome, pancreatic diseases, and also stress. The low level of glucose also indicates liver diseases or bacterial infection (http://www.9sites.org/pigcare/bloodwork.htm). The glucose levels in goat blood serum in the presented study were similar in both groups at the lower limit according to reference values. However, stronger fluctuations were observed in the control group than in the experimental one. The low level of glucose in both groups probably indicates a metabolic disorder, ketosis, which is a consequence of an imbalance of energy and protein in feed and, as reported by Amer et al. [9], it has already developed at the end of pregnancy when malnutrition occurred. In study Amer et al. [9], when the nutrient contents were above recommended level for goats, the average content of blood glucose was slightly above reference values (5.8 mg/l on days 7 and 28 of lactation). The higher stability of blood glucose content in the experimental group in our study could mean that yeast supplementation slightly improves glucose metabolism, even when the goats are underfed. These milder changes in glucose content in the experimental group may be due to the improvement in the digestibility of a diet containing yeast. It was probably caused by improvement of the rumen environment, which resulted in better development of microflora and improved digestion of the ration. Thus, the animals in the experimental group assimilated more energy from the available ingredients. Furthermore, the activity of AST and ALB content also underwent less fluctuation in the experimental than in the control group. Moreover, there were differences in AST and ALT activity, and ALB content between the control and experimental groups on the 180th day of lactation. Alanine transaminase (ALAT, ALT) is the intracellular enzyme occurring in the liver, skeletal muscles, myocardium and kidneys. ALT influences the formation of glutamate and pyruvate owing to the transfer of the amino group from alanine to ketoglutaric acid. Increased activity of this enzyme is caused by viral hepatitis, toxic liver damage or metabolic disorders, while decreased level means malnutrition or even starvation. The AST enzyme, similar to ALAT, is an intracellular enzyme, with the highest concentrations in the myocardium, liver, skeletal muscles, kidney and erythrocytes. AST influences the formation of glutamate and oxaloacetate owing to the transfer of the amino group from aspartate to ketoglutaric acid [10]. Increased activity of Aspartate transaminase (AST, AspAT) is caused by many reasons, as in the case of ALT, adding to this muscle damage and inflammation. Low activity of this enzyme also indicates malnutrition or starvation [11,12] (http://www.9sites.org/pigcare/bloodwork.htm). The higher activity of AST, ALT and ALB content in the experimental group than the control one after 180 days of supplementation could indicate the positive effect of yeast on liver function, and it could mean that due to the yeast supplementation the disturbances in homeostasis during lactation were lower. The values obtained for the activity of AST and ALT in the presented study was lower than references values. However, the laboratory analysis was done on frozen serum, stored at -20°C. Other researchers also indicate that their serum samples were frozen at -20°C prior to analysis [7,13]. On the other hand, in another study the blood was used for biochemical analysis within 12 h [14]. In accordance with our findings the values of enzyme activities presented in all the above-mentioned papers were under the lower limits of reference values. Therefore, in presented study, either the storage could have influenced the activity of enzymes, or these values, together with low blood glucose level, confirmed the insufficient feeding level of the animals.

Trait	Day of lactation	Control group	Experimental group	SE	Reference values#
		LSMEAN	LSMEAN		
Glucose	7	2.81 **a**	3.12	0.19	3 – 5.2 [mmol/l]
	30	3.27 **A**	3.27	0.20	
	80	3.38 **Ab**	3.47 **a**	0.19	
	120	2.82	2.97	0.29	
	180	2.36 **B**	2.82 **a**	0.21	
AST	7	92.02 **ab**	102.12	6.53	122 – 321 [U/l]
	30	112.67 **Ab**	101.57	6.99	
	80	111.56 **Ab**	100.79	6.53	
	120	85.20 **A**	89.37	9.65	
	180	71.84 **B***	89.96*	7.00	
ALT	7	15.55 **Aa**	18.28 **ab**	1.29	23 – 44 [U/l]
	30	20.25 **b**	21.15 **b**	1.38	
	80	20.34 **B**	21.15 **b**	1.29	
	120	20.30 **b**	22.42 **A**	1.90	
	180	13.17 **A***	16.81 **B***	1.38	
GGT	7	39.69 **A**	42.13	2.36	60 – 101 [U/l]
	30	50.55 **B**	48.67 **A**	2.53	
	80	51.73 **Ba**	47.03 **A**	2.36	
	120	42.70 **b**	41.64	3.49	
	180	33.22 **Aa**	35.90 **B**	2.54	
LDH	7	668.11 **A**	710.73 **A**	55.99	811 – 1250 [U/l]
	30	918.22 **B**	786.73 **A**	59.97	
	80	885.00 **B**	825.84 **A**	55.99	
	120	773.58	819.90 **A**	82.81	
	180	528.04 **A**	581.49 **B**	60.03	
ALB	7	31.57 **A**	31.82	1.33	25 – 44 [g/l]
	30	34.92 **A**	33.39	1.43	
	80	34.77 **A**	32.85	1.34	
	120	33.22 **A**	32.63	1.97	
	180	26.45 **B***	30.66*	1.43	

Table 1: Least square means of serum indicators of liver profile. (A,B – different letter within the columns and traits differ at $p<0.01$; a,b – different letter within the columns and traits differ at $p<0.05$; * - differences within the rows at $p<0.05$; #according to Winnicka – reference values of biochemical parameters in goat blood serum according to the International System of Units; AST-aspartate aminotransferase, ALT - alanine aminotransferase, GGT - gamma-glutamyl transferase, LDH - lactate dehydrogenase, ALB - albumins)

The next studied enzyme, GGT– gamma-glutamyltransferase (GGT, GGTP, gamma-GT), is connected with cellular membranes and mainly occurs in the liver, kidneys, pancreas and prostate. In humans, its increasing value may be a result of chronic and acute pancreatitis or acute hepatitis. A low level of GGT indicates malnutrition or even starvation [15] (http://www.9sites.org/pigcare/bloodwork.htm). The levels of GGT in the presented study were also under the lower limit of reference values during the whole lactation, which could also indicate either too long period of serum storage, or insufficient level of feeding of the animals. However, again the fluctuation of this enzyme during lactation was much slighter in the experimental group. This may also prove the positive influence of yeast supplementation on organism homeostasis.

Several studies on red and fallow deer showed that rise in plasma lactate dehydrogenase (LDH) activity might be a useful in vivo marker for tissue damage, injuries and diseases, because it is released during its damage [16]. This enzyme occurs extensively in blood cells, muscle, gut and liver cells, and it transfers hydrogen between molecules. LDH catalyzes the last step of the glycolytic pathway, namely the conversion of pyruvate to lactate and back. The low activity of LDH in the presented study could indicate muscle damage caused either by disturbances in diet balance, especially at the beginning of lactation, when the milk production is rising and it is difficult to cover the full needs of animals, or it is caused by too long a storage of blood serum before laboratory analysis.

Albumins (ALB), proteins produced in the liver, are responsible for maintaining blood volume, blood pressure, and binding of hormones, drugs and amino acids. The most common reason for increase of albumin concentration is dehydratation, while the decrease of serum albumins' levels is usually caused by malnutrition or starvation, burning, sepsis, injuries, or liver and kidney diseases [17] (http://www.9sites.org/pigcare/bloodwork.htm). The albumin levels in the presented study are in the range of the reference values (24-44 g/l). However, the level of these proteins in the blood of goats from the control group decreased dramatically at the end of lactation, while in the experimental group it stayed at the same level during the whole lactation. This might also confirm the positive influence of yeast supplementation on the health status of goats. Ujjwal and Dey [14] presented values as high as 200 g/l of albumins in the serum of healthy goats, while the level for animals infected with Sarcoptes scabiei was ten-fold lower.

The next biochemical indicator of liver profile – cholesterol – is an element of cellular membranes, and it is also a substrate for steroid hormones and bile acids production. The two most important fractions of cholesterol are High-density lipoprotein (HDL "good cholesterol"), and Low-density lipoprotein (LDL, "bad cholesterol"). An excess of LDL, together with products of the oxidation of unsaturated fatty acids, leads to an accumulation of cholesterol depositions in blood vessels, which is the most common cause of arteriosclerosis and coronary disease in humans [17] (http://www.9sites.org/pigcare/bloodwork.htm).

In the present study total cholesterol (TCHOL) content was usually slightly higher than the upper limit presented by Winnicka [17] for adult goats (Table 2). Moreover, there were differences in total cholesterol content in blood serum during lactation, with the highest peak in the middle of lactation when goats are pastured. Thus the diet influenced the cholesterol content in blood serum. However, the level of HDL was much higher than that of LDL, with the highest level in the summer period. This finding may confirm the positive effect of grazing dairy goats on their health status. These results slightly differ from those obtained on dairy cows. Ling et al. [18] found the lowest TCHOL content at the beginning of lactation, but then its content increased gradually throughout the lactation. Also, results presented by Jóźwik et al. [19] showed higher content of TCHOL on day 200 of lactation than on day 60. However, the stage of lactation in dairy cattle is usually not connected with the season of the year. Moreover, high yielding cows are mostly fed total mixed ration (TMR) and they do not graze.

Trait	Day of lactation	Control group	Experimental group	SE	Reference values#
		LSMEAN	LSMEAN		
TCHOL	7	2.29 **Aa**	2.86 **Aa**	0.21	1.6 – 2.8 [mmol/l]
	30	3.12 **B**	3.57 **Bb**	0.23	
	80	3.47 **B**	3.88 **B**	0.21	
	120	3.24 **Bb**	3.55 **Bb**	0.31	
	180	2.14 **A**	2.43 **A**	0.23	
LDL	7	0.56 **Aa**	0.77 **A**	0.11	Lack of information
	30	0.96 **b**	1.05 **a**	0.12	
	80	1.23 **B**	1.41 **Bb**	0.11	
	120	1.21 **B**	1.28 **B**	0.17	
	180	0.68 **A**	0.84 **A**	0.12	
HDL	7	1.31 **Aa**	1.54 **a**	0.10	Lack of information
	30	1.64 **b**	1.84 **Ab**	0.11	
	80	1.75 **B**	1.92 **Ab**	0.10	
	120	1.73 **B**	1.86 **Ab**	0.15	
	180	1.15 **A**	1.18 **Bb**	0.11	
Bilirubin	7	0.70 **a**	0.75	0.13	Lack of information
	30	0.69	0.69	0.14	
	80	0.39 **b**	0.62	0.13	
	120	0.53	0.69	0.22	
	180	0.61	0.78	0.14	
TRIG	7	0.19	0.30	0.04	0.1 – 0.3 [mmol/l]
	30	0.17	0.23 **A**	0.04	
	80	0.18	0.22 **A**	0.04	
	120	0.10 **a**	0.14 **A**	0.06	
	180	0.26 **b**	0.40 **B**	0.04	
Ca	7	2.07	1.99	0.11	2.2 – 3.05 [mmol/l]
	30	2.05	2.11	0.12	
	80	2.04	1.90 **a**	0.11	
	120	2.11	2.12	0.16	
	180	1.81*	2.79 **b***	0.12	
P	7	2.40 **A**	3.01 **A**	0.26	1.62 – 4.43 [mmol/l]
	30	2.90 **A**	3.16 **A**	0.28	
	80	2.84 **A**	3.46 **A**	0.26	
	120	2.19	2.30 **B**	0.39	
	180	1.64 **B**	1.84 **B**	0.28	
TP	7	59.29 **Aa**	61.39	2.37	59 – 78 [g/l]
	30	68.27 **Ab**	67.59 **A**	2.54	
	80	67.94 **A**	66.55 **A**	2.37	
	120	66.65 **A**	65.81 **A**	3.51	
	180	48.12 **B***	56.83 **B***	2.54	

Table 2: Least square means and their standard errors of blood serum indicators of liver profile, lipid and bone profile. (A,B – different letter within the columns and traits differ at $p<0.01$; a,b – different letter within the columns and traits differ at $p<0.05$; * - differences within the rows at $p<0.05$; #according to Winnicka [17]– reference values of biochemical parameters in goat blood serum according to the International System of Units; TCHOL - total cholesterol, LDL - low density cholesterol, HDL - high density cholesterol, TRIG – triglicerydes, Ca – calcium, P – phosphorus, TP – total protein)

There is a lack of information on appropriate bilirubin level in goat blood serum. In the present study bilirubin level was very stable in the experimental group, whereas its level decreased in the middle of lactation in the control group. Due to the potent antioxidant activity the bilirubin plays main physiological role as a cellular antioxidant [20]. Further, the meta-analysis of Novotný and Vítek [21] has revealed that level of serum bilirubin is inversely related to the risk of certain heart diseases in man. The sudden decrease of billirubin in the control group may indicate adverse changes in the oxidative status of these animals.

Triglyceride levels (Table 2), together with total cholesterol and both types of cholesterol, are also used as an indicator of lipid profile. There were higher fluctuations in triglycerides content in the experimental group, with the highest value at the end of lactation, even above the reference value. Triglycerides are synthesized and stored in fat and the liver until their utilization. They are a very important group of blood lipids because they are the major components of very-low-density lipoprotein (VLDL) and chylomicrons. They are an energy source and play a role in the transport of dietary fat (http://www.britannica.com/EBchecked/topic/605207/triglyceride). In humans, an increased level of triglycerides in the blood is connected with arteriosclerosis and the risk of heart disease and stroke. However, their level elevates temporarily for a period of time shortly after eating. There is limited information on the relationship between triglycerides level and the risk of disease in animals. However, it is considered as an indicator of proper nutrition [10]. Triglycerides are an important biochemical indicator of lipid profile because they are involved in storing fat and releasing fatty acids. Their low level indicates starvation or malnutrition, but there is no information about indicators of a high level of triglycerides [17]. A high level of triglycerides at the end of lactation in the presented study was found. The increased triglyceride levels could be the result of fat reserves mobilization due to the insufficient completion of energy demands.

The parameters of lipid and bone profiles (Table 2) changed parallelly in the control and experimental groups during lactation, and the differences between groups were found only in Ca and total protein (TP) content at the end of the experiment. Although the TP content in blood serum tended to decrease on day 180 of lactation in both groups, the decrease in the control group was much stronger, below the reference value. The calcium content was too low during the whole lactation, according to references, except the Ca content in the experimental group on day 180 of lactation. Proteins which are presented in blood serum play a role in osmotic regulation, the immunity system, and the transport of some substances [13]. A high level of TP indicates dehydration, inflammation, or chronic infection, while a low level indicates inter alia, intestinal malabsorption, liver disease, and losses through the kidneys. Moreover, a decrease in blood serum protein is caused by increased protein turnover due to stress [9] (http://www.9sites.org/pigcare/bloodwork.htm). The level of TP in the present study was at the lower limit of the reference value. Together with low level of calcium this could indicate either dietary mistakes in the investigated dairy goat herds, or temperature stress which occurred during the last sampling (August – the summer period in Central Europe).

There were no differences in creatinine levels in both group of animals, except at the end of lactation, when the CRE level was higher in the experimental group (Table 3). Creatinine is one of the biochemical markers that allow to monitore the kidney condition. Increased levels of creatinine in blood serum are most often observed in the case of dysfunction of kidneys, namely reduced filtration, shock or toxin ingestion, and muscle catabolism [22], while levels below references indicate liver disease or starvation.

Creatine kinase (CK, CLK) is located mainly in muscles, the myocardium and the brain. Increased level of CLK may appear after exertion. Moreover, an increased level of CLK is one of the symptoms during myocardial infarction, muscle trauma or damage. Further, poisoning by strychnine or carbon monoxide is another reason for increased values of CLK. In the present study the levels of CLK was higher than the upper limit of reference values in both groups (Table 3). This phenomenon is difficult to explain because the blood was collected before noon, after morning milking and before feeding, and thus the animals were not exerting any effort, unless the driving of the goats to the milking parlour or the taking of blood samples by a veterinarian resulted in stress of the animals.

The concentrations of minerals in goat milk as well as blood serum undergo some changes during the year because their concentrations depend on many factors. However, the major factor is a sufficient supply of essential macro- and microelements in a diet [23]. The diet of the investigated animals was constantly supplemented with a vitamin and mineral premix and mineral lick throughout the year. The content of calcium in the experimental group tended to be highest on day 180 of lactation, whereas in the control group it was the lowest. Despite the fact that the diet was supplemented with premix, the calcium level was slightly lower than the lower limit of references in both of the studied groups, which probably means dietary imbalance, intestinal malabsorption, or low intake of vitamin D. However, elevated level of Ca at the end of lactation in the experimental group could also indicate that the yeast supplementation improved intestinal absorption of calcium. Phosphorus, which is associated with calcium, has a big influence on metabolic processes. A high level of P indicates, for example, kidney disease, dietary imbalance or elevated ingestion of vitamin D, while a low level of this macro element indicates dietary imbalance (http://www.9sites.org/pigcare/bloodwork.htm). The level of phosphorus in the presented study ranged within reference values during entire experimental period, although it underwent some fluctuations during lactation.

There were also no differences in the experimental group in other macro element contents, such as chloride, iron, potassium, magnesium and sodium between the stages of lactation (Table 3). The opposite results were observed in the control group, where most macro element contents were lowest on day 180 of lactation. Sodium and potassium are important factors in maintaining normal function of muscles and nerves. Sodium is also an important electrolyte in every part of the body, and its high level indicates, e.g. dehydration or lack of water. On the other hand, low levels of sodium and potassium indicate inter alia, starvation, severe diarrhea or metabolic acidosis. Chloride is important, first of all, in maintaining the acid balance in blood. A high level indicates, e.g. dehydration, metabolic acidosis, or kidney disease, while a low level indicates metabolic alkalosis [17] (http://www.9sites.org/pigcare/ bloodwork.htm). Iron deficiency causes anemia, whereas deficiency in magnesium causes hypomagnesemic tetany (grass tetany). However, deficiency of potassium or iron is very rare in goats, especially in grazing animals. Moreover, deficiency of magnesium is less common in goats than in cattle, and goats have the ability to compensate for the lack of this element in the forage by decreasing the excretion of magnesium. If animals have free access to licks, they have no nutritional problems connected with lack of chloride or sodium [24]. Apart from calcium, chloride, and sodium at the last sampling in the control group, the contents of minerals in the serum of animals in both groups were within reference values. The lower level of calcium, total protein, chloride, potassium, magnesium and sodium in the blood serum of the control group than in the experimental one, together with higher activity of AST, ALT and ALB content on day 180 of lactation indicate some unidentified negative factors which influenced the animals in this herd. However, all animals were kept under the same conditions, and thus the lack of any impact of these factors on the goats in the experimental group might mean that yeast supplementation had a positive influence on the metabolism of animals and on the intestinal absorption of minerals.

Different patterns in lipase content were observed during lactation. There were no differences in its content in the control group during lactation, while in the experimental group its content was highest at the beginning of lactation and decreased after the peak of lactation (e.g. after day 80). The high activity of lipase in the experimental group indicates increased lipolytic processes (*hydrolytic activities) against a triglyceride substrate* in tissues after yeast supplementation. However, all values ranged within references.

In the present study only some biochemical parameters were influenced by yeast supplementation (Tables 2-4). Furthermore, almost all indicators of liver profile changed during lactation simultaneously in both groups. However, some of them, such as glucose, AST, ALB, creatinine kinase, and almost all the minerals studied, such as Cl, Fe, K, Mg, and Na characterized the most stable values in the yeast supplemented groups, and more than the control group during lactation (Table 1 and 3). However, triglicerydes and lipase contents were more variable in the experimental group than in the control one (Table 2).

There are several studies indicating the positive influence of yeast supplementation on biochemical parameters [5] or the animal immune system [4,25]. However, there are also contradictory results [6]. Moreover, Nikkhah et al. [26] did not confirm the influence of a yeast culture supplemented diet on concentrations of total protein, urea, glucose, cholesterol, triglycerides or mineral substances in the blood of cows. In the present study most of the biochemical parameters were influenced by the stage of lactation in both groups. However, some of them were influenced by yeast supplementation. Moreover, some of them showed less fluctuation during lactation in experimental group, which also indicate positive influence of yeasts supplementation on homeostasis maintenance.

The contents of some biochemical parameters under (glucose, AST, ALT, GGT, LDH, Ca) or above (creatinine kinase) reference values indicate feeding disturbance during lactation. This indicates that the diet was not properly balanced according to the requirements of the animals, maybe because of lower nutritional value of feed than are specified standards. Dietary mistakes made in this herd may indicate a lack of sufficient knowledge and experience of goat owners in general. Perhaps among the owners of goats the small nutritional requirements of goats still prevails. This applies, however, only to goats of local breeds with low milk yield. High producing dairy goats, similarly as high producing dairy cows, should be supplied with sufficient amount of energy and nutrients. Every effort in training farmers on the proper nutrition of dairy goats is essential and required.

Trait	Day of lactation	Control group LSMEAN	Experimental group LSMEAN	SE	Reference values#
CRE	7	55.80	58.34	3.54	Lack of information
	30	54.75	63.13	3.70	
	80	48.21	55.26	3.45	
	120	55.46	58.77	5.11	
	180	48.20 *	60.73 *	3.70	
CK	7	147.16 **A**	178.42	18.29	28 – 130 [U/l]
	30	166.13	188.87	19.58	
	80	212.38 **Ab**	209.09 **a**	18.28	
	120	183.35 **B**	181.57	27.04	
	180	124.92 **B**	142.34 **b**	19.06	
Cl	7	101.90 **A**	107.92	2.71	98 – 111 [mmol/l]
	30	106.80 **A**	106.93	2.90	
	80	105.32 **A**	106.60	2.71	
	120	99.32 **A**	101.15	4.00	
	180	89.31B **B****	108.70**	2.90	
Fe	7	24.31**A**	24.68	1.76	14.3 – 39.4 [µmol/l] (sheep)
	30	31.74B **a****	22.29**	1.88	
	80	26.23 **b**	23.81	1.76	
	120	18.66 **Aa**	21.05	2.60	
	180	21.54 **A**	20.63	1.88	
K	7	4.05 **a**	4.08	0.13	2.5 – 4.1 [mmol/l]
	30	4.27 **A**	4.19	0.14	
	80	4.06 **a**	4.26	0.14	
	120	4.11 **a**	4.23	0.20	
	180	3.59B **b****	4.23**	0.15	
Mg	7	1.09 **A**	1.18	0.07	0.74 – 1.62 [mmo/l]
	30	1.28 **A**	1.16	0.08	
	80	1.26 **A**	1.18	0.08	
	120	1.14 **a**	1.12	0.11	
	180	0.79B **b***	1.00*	0.08	
Na	7	139.94 **A**	146.99	3.88	141 – 157 [mmol/l]
	30	144.07 **A**	149.27	4.15	
	80	145.09 **A**	148.58	3.87	
	120	138.60 **A**	142.09	5.74	
	180	122.50 **B****	147.22**	4.16	
Lipase	7	16.25*	22.23 **A***	1.59	0 – 71 [U/l] (sheep)
	30	14.88*	20.27 **Aa***	1.70	
	80	15.48	18.74 **AB**	1.59	
	120	12.48	15.67 **Bb**	2.35	
	180	14.58	14.99 **Bb**	1.71	

Table 3: Least square means and their standard errors of blood serum indicators of kidney profile and mineral element contents. (A,B – different letter within the columns and traits differ at $p<0.01$; a,b – different letter within the columns and traits differ at $p<0.05$; ** - differences within the rows at $p<0.01$; * - differences within the rows at $p<0.05$; #according to Winnicka [17] – reference values of biochemical parameters in goat blood serum according to the International System of Units; CRE – creatinine, CK – creatinine kinase, Cl – chloride, Fe – iron, K – potassium, Mg – magnesium, Na – sodium)

Conclusion

In the present study some biochemical indicators had very low values or even values below physiological limits (glucose, AST, ALT GGT LDH, calcium, total protein), which means that the diet of the animals was not properly balanced, or there was a malnutrition problem. However, the values in the experimental group underwent much lower fluctuations during lactation, and thus we assume that yeast supplementation could improve intestinal absorption of minerals.

Acknowledgment

This research was conducted as part of the project "BIOFOOD – innovative, functional products of animal origin" No. POIG. 01.01.02-014-090/09 co-financed by the European Union from the European Regional Development Fund under the Innovative Economy Operational Programme 2007 – 2013 and IGAB project S.IV.2.

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