

Article

Investigating the Effects of Diatomite on Biochemical Values and the Number of Fecal Eggs in Kilis Goats Naturally Infected with Parasites

Parazitlerle Doğal Olarak Enfekte Olan Kilis Keçilerinde Diatomitin Biyokimyasal Değerler ve Dışkıdaki Yumurta Sayısı Üzerindeki Etkilerinin Araştırılması

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ABSTRACT

Increased parasite load and poor quality feeds negatively affect productivity and growth rates in livestock farming. Diatomite, an organic feed additive an alternative natural anthelmintic, is used as an effective biological agent to control parasites in farm animals. The aim of this study is to determine whether or not the use of Diatomite as a feed additive in animals will give effective results in biological control against parasites and cause significant differences in the biochemical parameters to be obtained as a result of the treatment of parasitic diseases in animals, and to identify whether or not the use of Diatomite as an alternative to chemical drugs will reduce the negative effects of possible chemical residues in goats' meat and milk.

In this study, 15 Kilis goats, which were aged 18-42 months, weighed 23-50 kg, were infected with natural parasites, were used. The animals were divided into 3 groups including 5 animals of different ages and weights in each; control group, experimental group I (fed with 5% Diatomite added feed for 8 weeks), and experimental group II (fed with 10% Diatomite added feed for 8 weeks).

Urea ($p<0.05$), uric acid ($p<0.01$), total cholesterol ($p<0.05$), LDL ($p<0.05$), CK ($p<0.001$), iron ($p<0.05$), LDH ($p<0.001$), and UIBC ($p<0.05$) were measured as biochemical parameters in the study and it was determined that there were significant differences in the number of fecal parasite eggs. It is thought that the addition of 5% and 10% Diatomite into the rations of animals gave positive results in biochemical values and the number of fecal parasite eggs reduced. In conclusion, it is thought that the addition of Diatomite to the feed of Kilis goats will be effective in combating parasites and cause significant differences in biochemical parameters and more comprehensive further studies are needed.

Keywords: Biochemical parameters; diatomite; parasite; Kilis goats.

ÖZET

Hayvancılıkta artan parazit yükü ve düşük kaliteli yemler verimliliği ve büyüme oranlarını olumsuz etkiler. Alternatif doğal bir antelmintik olarak kabul edilen organik bir yem katkı maddesi olan diatomit, çiftlik hayvanlarında parazitleri kontrol etmek için etkili bir biyolojik ajan olarak kullanılmaktadır. Bu çalışmanın amacı, hayvanlarda yem katkı maddesi olarak diatomit kullanımının parazitlere karşı biyolojik kontrolde etkili sonuçlar verip vermeyeceğini ve hayvanlarda parazitler hastalıkların tedavisi sonucunda elde edilecek biyokimyasal parametrelerde önemli farklılıklara yol açıp açmayacağını belirlemek ve kimyasal ilaçlara alternatif olarak diatomit kullanımının keçilerin et ve sütündeki olası kimyasal kalıntıların olumsuz etkilerini azaltıp azaltmayacağını tespit etmektir.

Bu çalışmada, 18-42 aylık, 23-50 kg ağırlığında, doğal parazitlerle enfekte edilmiş 15 Kilis keçisi kullanılmıştır. Hayvanlar, her birinde farklı yaş ve ağırlıkta 5 hayvan bulunan 3 gruba ayrılmıştır; Kontrol grubu, deney grubu I (8 hafta boyunca %5 diatomit ilave edilmiş yemle beslenen) ve deney grubu II (8 hafta boyunca %10 diatomit ilave edilmiş yemle beslenen) olmak üzere üç gruba ayrılmıştır.

Çalışmada biyokimyasal parametreler olarak üre ($p<0.05$), ürik asit ($p<0.01$), toplam kolesterol ($p<0.05$), LDL ($p<0.05$), CK ($p<0.001$), demir ($p<0.05$), LDH ($p<0.001$) ve UIBC ($p<0.05$) ölçülmüş ve dışkı parazit yumurtası sayısında anlamlı farklılıklar olduğu belirlenmiştir. Hayvanların rasyonlarına %5 ve %10 diatomit ilavesinin biyokimyasal değerlerde olumlu sonuçlar verdiği ve dışkı parazit yumurtası sayısını azalttığı düşünülmektedir. Sonuç olarak, Kilis keçilerinin yemine diatomit eklenmesinin parazitlerle mücadelede etkili olacağı ve biyokimyasal parametrelerde önemli farklılıklara yol açacağı düşünülmektedir; ancak daha kapsamlı ileri çalışmalar gerekmektedir.

Anahtar Kelimeler: Biyokimyasal parametreler; diatomit; parazit; Kilis keçileri.

1. INTRODUCTION

Livestock is an important component of agricultural activities as it meets many basic needs of the human population all over the world such as meat, oil, milk, eggs and wool (Emeruwa, 2016). Kilis goat is a crossbreed goat of Hair Goat and Aleppo Goat and accounts for approximately 25.6% of total goat wealth in Turkey. It is reared in Kilis, Şanlıurfa, Gaziantep and Hatay provinces in the Southeastern Anatolia region, which is suitable for Kilis goat breeding in terms of vegetation (Iriadam, 2004). Kilis goats have generally brown and black body color among domestic breeds, are highly resistant to diseases and harsh environmental conditions, and have a high milk yield (Ünalan & Ceyhan, 2017). Parasitic diseases in sheep and goats are important for Veterinary Medicine and Public Health (Özkurt et al., 2012). The total annual economic loss caused by *H. contortus* in sheep and goats in Türkiye has been estimated at 6.60 billion TL (Küçükoflaz et al., 2025). Widely used antiparasitic drugs and antibiotics are the main obstacles to the certified organic farming. Many farmers take various measures against problems for good nutrition and stress reduction (Emeruwa, 2016). One of the alternative control methods in the fight against parasites is addition of diatomite into animal rations. Diatomite is a sediment composed of the fossilized siliceous shells of eukaryotic and microscopic algae called as single-cell siliceous algae (diatoms) that accumulate on freshwater or bottom of the sea (Bernard et al., 2009; Di Gregorio et al., 2014). The sharp edges of the diatomite mechanically break the skin of the nematode, thus causing death due to water loss (Ahmed et al., 2013). Biochemical parameters are used to diagnose diseases in animals and to increase productivity. Results from clinical studies provide information about the early diagnosis, pathogenesis, course and methods applied for the treatment of the disease (Duygu et al., 2013). Studies have reported that there are significant changes in hematological and biochemical data obtained before and after treatment in parasitic diseases. Zinc, copper and iron levels decreased in sheep infected with gastrointestinal parasites and increased again as a result of treatment. It was also reported that erythrocyte counts, hematocrit and hemoglobin values decreased in lambs with the presence of parasites (Çimtay & Sevgili, 2003). The differences in plasma cholesterol and lipoprotein levels in farm animals have effects on live weight (Karaalp & Çimen, 2005). The biochemical profile of the blood is necessary for diagnosing the disease, monitoring its course and following the response to treatment, and the evaluation of biochemical parameters in animals is very important for clinical studies. Determining the biochemical reference values specific to the region they live in is

useful in diagnosing diseases and solving nutritional problems (Dede et al., 2014; Nisbet, et al., 2006).

The aim of this study is to determine whether or not the use of Diatomite as a feed additive in animals may be effective in biological control against parasites and cause possible changes in biochemical parameters depending on the treatment of parasitic diseases, and to identify whether or not the use of Diatomite as an alternative to chemical drugs will reduce the negative effects of possible chemical residues in goats' meat and milk. This study also aimed to determine the changes caused the use of Diatomite in biochemical data, especially in cholesterol values.

2. MATERIALS AND METHODS

Our research received ethical approval from the Harran University Animal Experiments Local Ethics Committee Presidency, based on decision number 01-08, dated 20/11/2017 and session number 2017/007.

In this study, which is widely used in the livestock sector in our region Kilis (15) goats which were naturally infected with parasites, aged 18-42 months and weighed 23-50 kg, were examined in Research and Development farm of Harran University. The animals were divided into a total of 3 groups including 5 animals of different ages and weights in each. The groups were placed in different parts in the barn so as not to interfere with each other. Unprocessed Diatomite samples supplied from Bey-Tuğ Mineral company were photographed using a Scanning Electron Microscope (SEM) at Harran University Science and Technology Application and Research Center (Hübtam) (Figure 1).

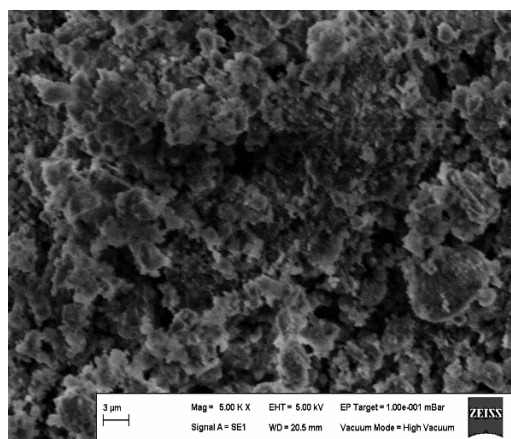


Figure 1. SEM image of Diatomite (x500K)

- Animals in control group were given normal feed and water ad libitum and followed for 8 weeks.
- Animals in group I were fed for 8 weeks by adding 1.5 kg of normal dry feed and 75 g (5%) of Diatomite into their ration per day.

- Animals in group II were fed for 8 weeks by adding 1.5 kg of normal dry feed and 150 g (10%) of Diatomite into their ration per day.

After the groups were formed, control group animals were fed normally, group I animals were fed feed supplemented 5% of dry feed with diatomite, and group II animals were fed feed supplemented 10% of dry feed with diatomite. It was observed that the animals consumed the diatomite given with the feed 1.5 kilograms of dry feed per day for each animal. Blood samples were taken from the jugular veins of all animals into heparinized tubes for biochemical analysis. The samples were analyzed using the ARCHITECT c16000 fully automatic clinical biochemistry analyzer in the Laboratory of the Biochemistry Department of the Faculty of Medicine of Harran University. Parasite egg counting in fecal samples taken from the animals was done by using McMaster method, and blood and fecal samples were collected every two weeks and stored at -80°C. The presence of *Eimeria* Sp. oocyst was mostly detected.

By the end of the eighth week the samples were taken and analyses were conducted. EGGBiochemical parameters such as urea, creatinine, uric acid, ALT, GGT, total protein, albumin, triglyceride, total cholesterol, HDL, LDL, CK, LDH, iron and UIBC were determined.

2.1 Statistical analysis

Minitab 17 software was used in the analysis of all data. The data were statistically analyzed with the Levene's test for the assumption of variance equality and the Shapiro Wilk test for the assumption of normality ($p > 0.05$). The GLM (General Linear Model) procedure for biochemical parameters and Tukey HSD test were used to determine the differences between the groups. The non-parametric Kruskal-Wallis test was used to determine the difference between the groups, the Friedman test for repeated measurements, and the Wilcoxon signed-rank test for multiple comparisons. Data were presented with mean rank, minimum, maximum, and the chi-square values. The significance level was calculated as $p < 0.05$ in all the tests.

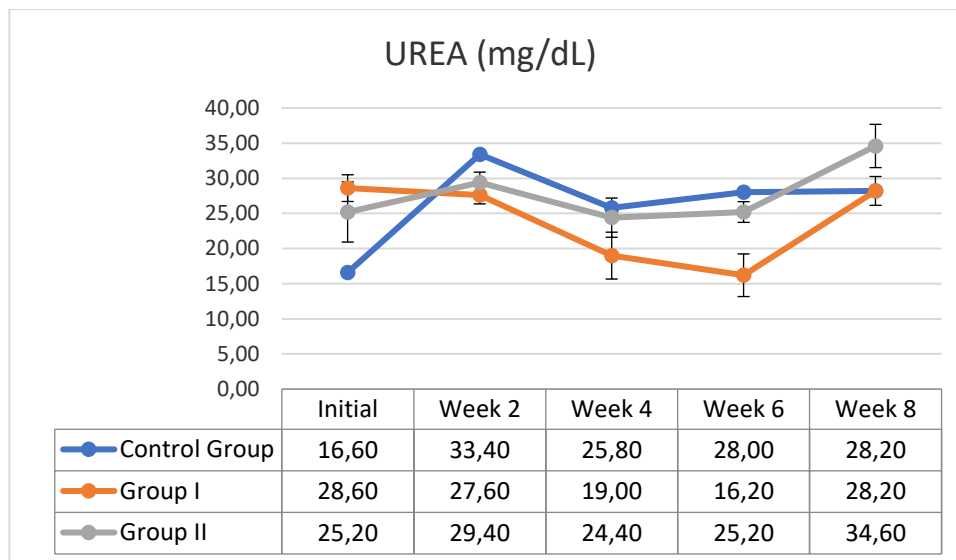
3. RESULTS

The biochemical parameters of all the groups depending on time, no statistically significant difference was observed in ALT, GGT, albumin, total protein, HDL values among the groups. On the other hand, statistically significant differences were found between uric acid, CK ($p < 0.05$), total cholesterol, iron ($p < 0.01$), urea, LDH and UIBC ($p < 0.001$) values (Table 1).

Table 1. Time dependent biochemical parameters of control group, group I and group II

	Unit	n	Baseline	2 nd week	4 th week	6 th week	8 th week	p
ALT	U/L	5	16.61±4.03 A	15.00±5.54 A	15.08±4.27 A	17.28±4.79 A	16.93±5.16 A	0.275
GGT	U/L	5	56.05±15.87 A	53.87±8.30 A	50.40±7.98 A	49.73±8.99 A	48.27±9.37 A	0.213
Total Protein	mg/dl	5	7.77±0.50 A	7.47±0.65 A	11.61±16.16 A	7.37±0.54 A	7.73±0.74 A	0.456
Albumin	mg/dl	5	2.70±0.22 A	2.57±0.29 A	2.59±0.27 A	2.1±0.30 A	2.61±0.33 A	0.062
HDL	mg/dl	5	38.40±11.60 A	36.40±10.74 A	35.53±8.65 A	37.80±5.74 A	35.73±7.19 A	0.713

The urea datas were determined that the mean urea value in the control group increased significantly in the 2nd week, and it was higher than the baseline value until the end of the 8th week. The mean urea values of the animals in the group I decreased until the end of the 6th week. The mean urea values of the animals in the group II increased in the 2nd week, decreased in the 4th and 6th weeks, and reached the highest value in the 8th week (Figure 2).

**Figure 2.** Control, I. and II. urea parameters of groups ($p < 0.05$)

Moreover, the uric acid values of the control group increased from the beginning to the end of the 8th week; the values of the group I decreased but, the values of the group II

increased continuously from the beginning (Figure 3).

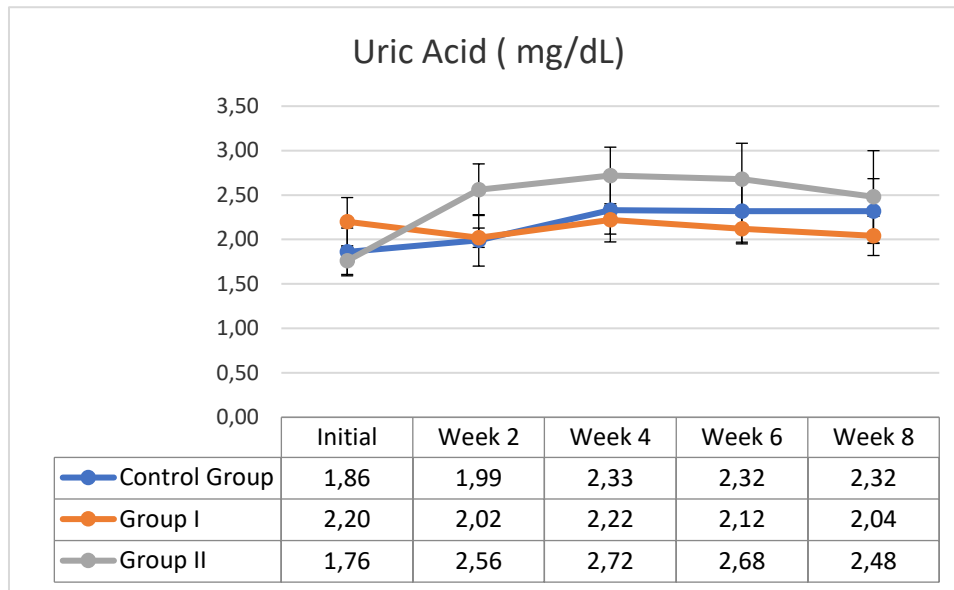


Figure 3. Control, I. and II. uric acid parameters of groups ($p<0.01$)

Total cholesterol values of the control group and group II decreased in the 2nd week, and the group I had the lowest value at the 8th week (Figure 4).

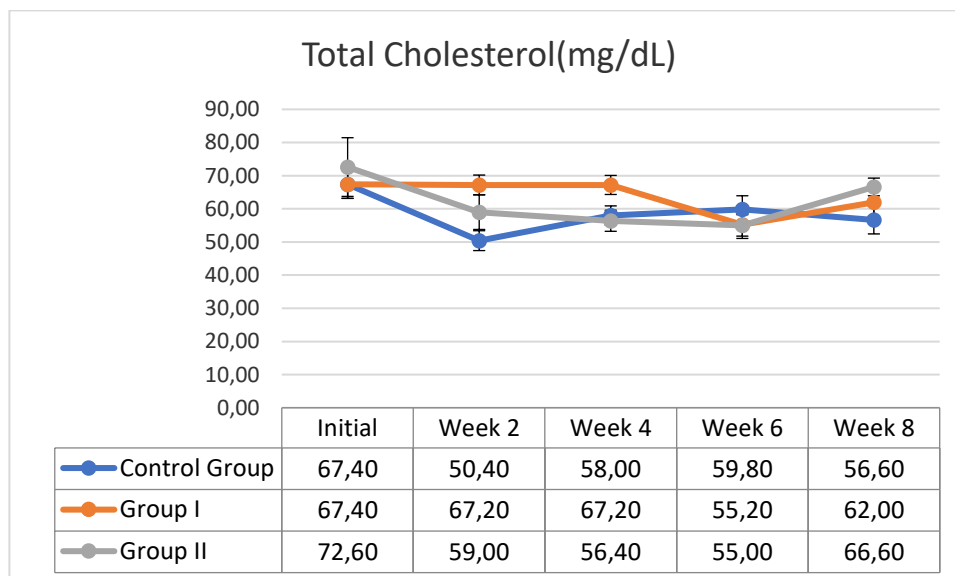


Figure 4. Control, I. and II. total cholesterol parameters of groups ($p<0.05$)

For CK values, the control group showed the highest decrease in the 2nd week, the lowest value was determined in the group II in the 4th week and the group I in the 8th week, and the CK value of the group II increased after the 4th week (Figure 5).

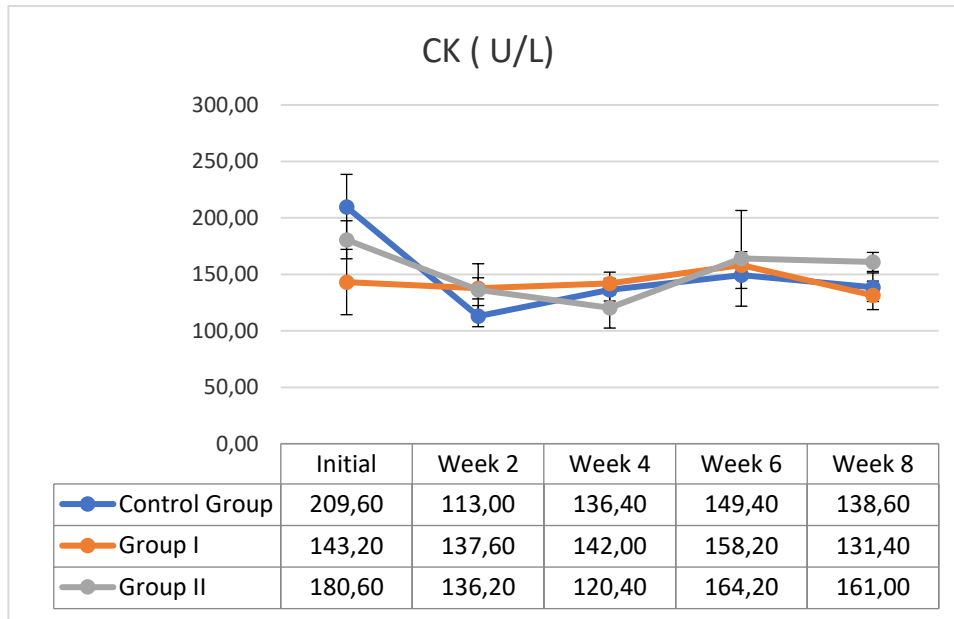


Figure 5. Control, I. and II. CK parameters of groups ($p<0.001$)

For LDH values, the 6th week values were the highest and the 8th week showed a decrease in the all of the groups (Figure 6).

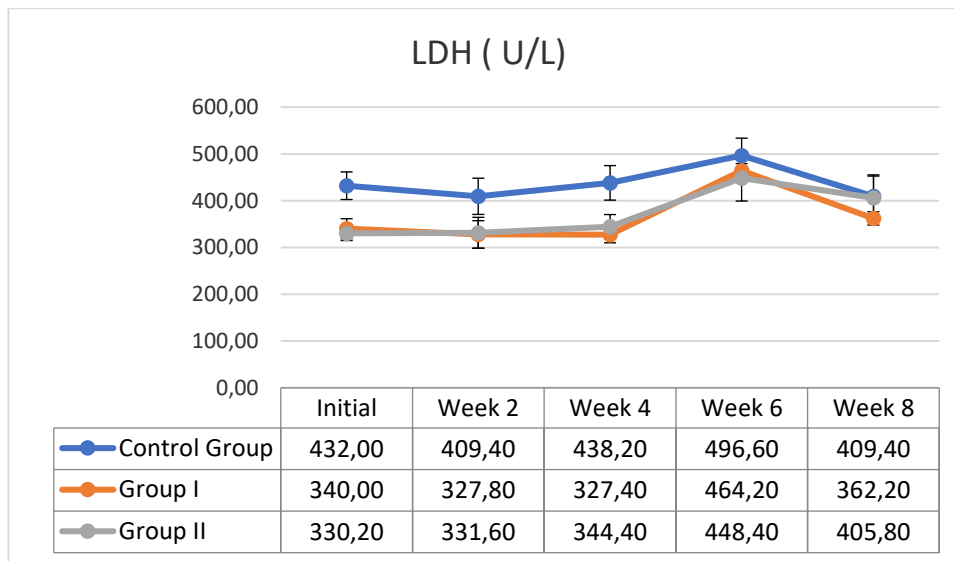


Figure 6. Control, I. and II. LDH parameters of groups LDH ($p<0.001$)

Especially the Fe values of the group I showed a continuous increase until the 6th week, values of the control group and the group II were the highest in the 6th week (Figure 7).

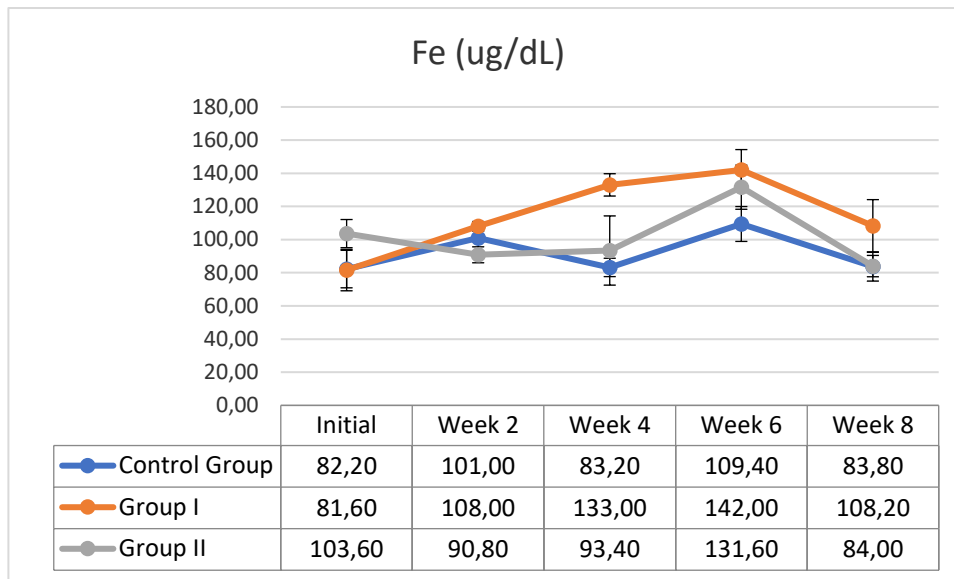


Figure 7. Control, I. and II. Fe parameters of groups ($p < 0.05$)

The UIBC values of the groups I and II decreased significantly until the 4th week and were the highest in the 8th week. The values of the control group tended to decrease until the 6th week and increased in the 8th week (Figure 8).

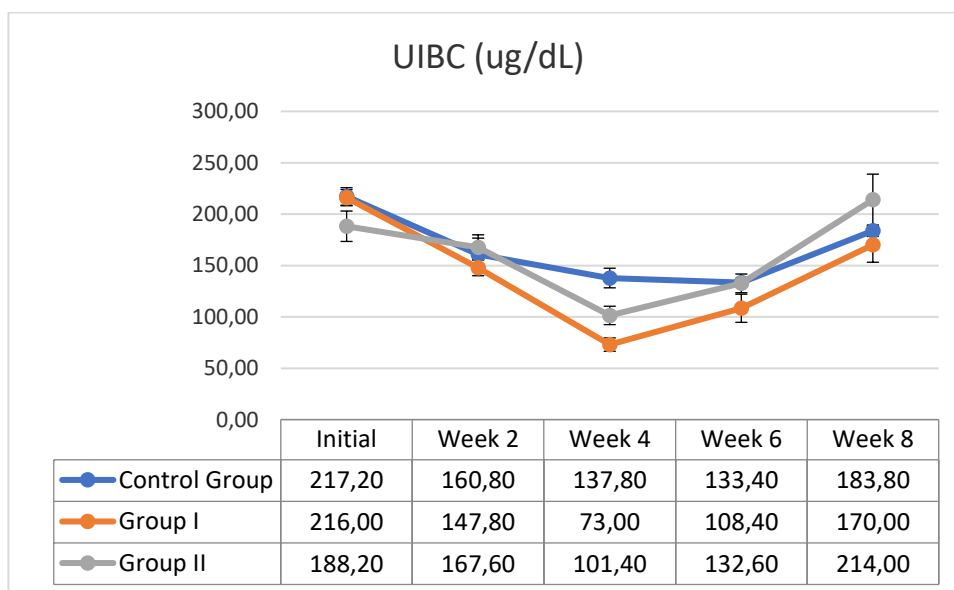


Figure 8. Control, I. and II. UIBC parameters of groups ($p < 0.05$)

3.1 Fecal Egg Counts

The parasite eggs of the groups I and II: a statistical difference was determined between the groups at the level of $p < 0.05$ (Table 2).

Table 2. Control, I. and II. fecal egg count in groups

		Initial	Week 2	Week 4	Week 6	Week 8
	<i>n</i>	Mean	Mean	Mean	Mean	Mean
Control	5	10.80 A	11.50 A	11.40 A	12.00 A	12.80 A

		Initial	Week 2	Week 4	Week 6	Week 8
	<i>n</i>	Mean	Mean	Mean	Mean	Mean
Group I	5	5.50 A	7.10 A	6.00 A A	8.5 B	4.60 B
Group II	5	7.70 A	5.40 A	6.60 A	3.5 B	6.60 B
$\chi^2_{(2)}$		2.059	5.879	4.551	9.207	9.206
<i>p</i>		0.165	0.053	0.103	0.01*	0.01*

The fecal egg numbers were observed that the number of fecal parasite eggs in the control group increased, the number of eggs in the group I was the highest in the 6th week and decreased significantly in the 8th week, and the lowest number of fecal parasite eggs in the group II was determined in the 6th week. The increase in fecal egg counts in the second observation group from week 6 to week 8 may be due to external factors (Figure 9).

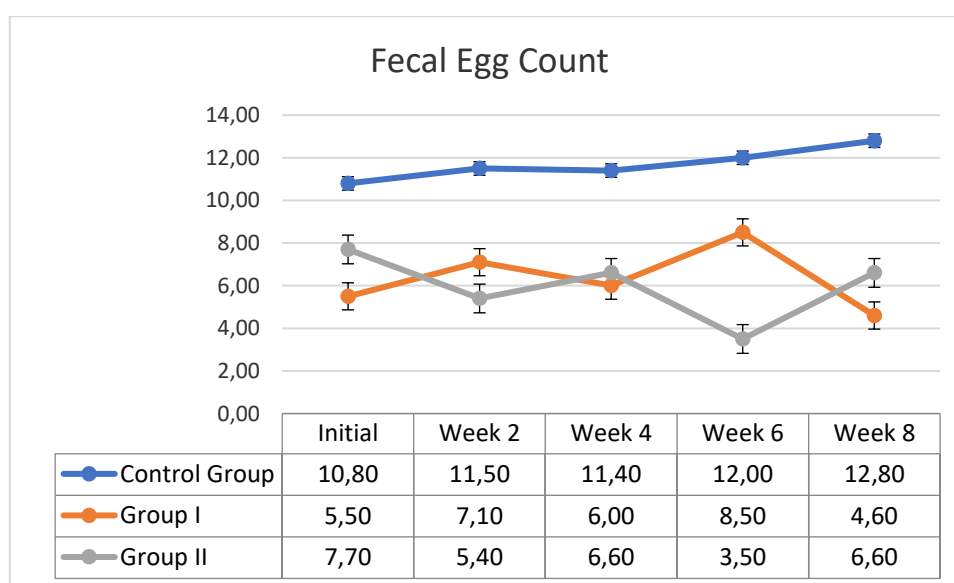


Figure 9. Fecal egg counts of groups ($p= 0.01$)

4. DISCUSSION

Recent studies have emphasized the importance of biochemical parameters in the treatment of parasitic diseases. When diatomite is used as a food additive in goats, sheep, poultry and humans, it causes a decrease in the number of fecal parasite eggs and significant changes in

biochemical parameters (Ikusika et al., 2019; Martel-Kennes et al., 2016; Nkwana et al., 2019; Wachter et al., 1998).

Ewuola et al., conducted a study on roosters in 2014 and determined that blood urea and cholesterol values significantly reduced in birds fed for 12 weeks by adding %6 diatomite into the ration compared to the control group.

In their study on goats in 2009, Bernard et al., stated that there were significant differences in FEC (fecal parasite egg count).

In the present study, when the changes in the biochemical parameters of the groups I and II were compared over time, no significant difference was found between ALT, GGT, albumin, total protein and HDL values. On the other hand, significant differences were found in urea, uric acid, CK, total cholesterol, LDH, iron and UIBC values.

Findings of Emeruwa's two studies in 2016 and 2018 indicated that there were no significant differences between urea, protein, and cholesterol values, but the addition of %2 -6 Diatomite was effective in glucose values. The findings of the present study demonstrated significant differences between urea, uric acid, CK, total cholesterol, LDH, iron, and UIBC values. According to the findings, the use of diatomite in high doses and for a short time as a feed additive had a positive effect on the result (reduction in the number of fecal parasites, decrease in total cholesterol value, and increase in iron value).

In the study by Bernard et al., in 2009, increasing doses of Diatomite were added into the feed of 20 goats naturally infected with parasites for 6 weeks, and they reported no decrease in the number of fecal eggs in the fecal samples taken.

In a study conducted by Jones O in 2020 to determine the possible effects of diatomite and copper oxide wire particles on nematodes in gastrointestinal system of sheep, it was stated that diatomite alone had a positive effect on the number of fecal parasite eggs, but its combination with copper oxide did not show any effect (Jones, 2020; Quarles, 1992).

In an in vitro study conducted by Beltran et al., in 2015 to determine the migration inhibition of *Oesaphagostomum dentatum* larvae, %6 food additive Diatomite was found to cause inhibition in fecal larvae (Beltran & Martin, 2016).

Sooby et al. suggested in 2007 that Diatomite is an effective anthelmintic. However, Bernard et al., stated that Diatomite could not be an effective alternative anthelmintic for all nematodes in their study on goats (Sooby et al., 2007).

Ahmed et al., reported that although no change was detected in the number of fecal parasite eggs, the use of %2 Diatomite caused a significant reduction in the number of fecal

larvae in their in vivo study in Merino sheep naturally infected with *Haemonchus contortus* in 2013.

Philip reported that the addition of Diatomite into the feed of dairy cows prevented insect damage as well as virus spread and the incubation period of helminths; and also stated that Diatomite increased the rate of digestion and had positive effects on the health and growth rate of young animals (Philip, 2003).

Changes in parameters related to protein metabolism (urea, uric acid), lipid metabolism (total cholesterol, LDL), muscle enzymes (CK, LDH), and mineral metabolism (iron, UIBC) indicate that diatomite may have an effect on metabolic processes. However, there is no clear evidence that the findings obtained indicate a negative picture in terms of animal health.

When the fecal parasite egg numbers of the groups I and II were examined depending on time in the present study, it was determined that there were significant decreases in the values of the 8th week in the group I and the 6th week in the group II. Possible reason for the resurgence in parasite counts during weeks 6 and 8 may be reinfection from pasture sources. Given the life cycle of gastrointestinal nematodes, it is possible for animals to continuously ingest infective third-stage larvae (L3) present in the environment. While the initial parasite load decreased, egg shedding may have risen again in the following weeks due to new infections acquired from the pasture. The fact that the prepatent period of nematodes typically ranges from 2 to 8 weeks provides biological support for the increase observed in weeks 6–8 of the study (Taylor, Coop, & Wall, 2015).

5. CONCLUSIONS

Given that the presence of parasites leads to growth retardation in animals and causes a decline in meat, milk, and wool production, the use of diatomaceous earth as a feed additive in animals is expected to yield positive results regarding fecal egg counts and certain biochemical parameters. The findings obtained by adding diatomite as a feed additive to the diet of Kilis goats naturally infected with parasites over an 8-week period, when considering its effects on fecal egg count, urea, uric acid, CK, total cholesterol, LDH, iron, and UIBC levels are considered significant in guiding future studies.

Acknowledgments

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Conflict Of Interests

No conflicting interests and no funding in connection with this paper are applicable.

LIMITATIONS

This study has certain limitations. In addition to analyses of the physical and chemical composition of diatomite, an examination of average daily feed intake data would contribute to the evaluation. Furthermore, the study was conducted under specific environmental and management conditions; therefore, additional studies involving larger populations and longer follow-up periods would provide more useful data to validate these findings.

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