Eurasian Journal
of Veterinary Sciences

www.eurasianjvetsci.org

RESEARCH ARTICLE

Effect of lactation number on some biochemical parameters in postpartum dairy cows

Taha Burak Elifoglu [1*], Serdal Kurt [2]

[1]Kirikkale University, Veterinary Faculty, Department of Obstetrics and Gynaecology, Kirikkale, Turkey
[2]Kahramanmaras Istıklal University, Elbistan Vocational School, Department of Veterinary, Kahramanmaras, Turkey

Received:02.10.2022, Accepted: 29.11.2022
*tbelifoglu@kku.edu.tr

Postpartum süt ineklerinde laktasyon sayısının bazı biyokimyasal parametreler üzerine etkisi

Eurasian J Vet Sci, 2022, 38, 4, 248-253
DOI: 10.15312/EurasianJVetSci.2022.389

Öz

Amaç: Sunulan çalışmanın amacı, süt ineklerinde laktasyon sayısı, süt verimi ve bazı biyokimyasal parametreler arasındaki ilişkiyi araştırmaktır.

Gereç ve Yöntem: Çalışmanın materyalini süt inekleri (n=60) oluşturdu ve inekler laktasyon sayılarına göre üç farklı gruba ayrıldı. Laktasyonda olmayanlar (düveler) Grup 1'e (n=10), 1. ve 2. laktasyondaki inekler Grup 2'ye (n=24), 3. ve 4. laktasyondaki inekler Grup 3'e (n=26) kaydedildi. Gruplardaki ineklerin kan total protein, albümin, kan üre nitrojen (BUN) kalsiyum, fosfor, magnezyum, glukoz, kolesterol, aspartat transaminaz (AST) ve gama-glutamil transpeptidaz (GGT) düzeyleri ölçüldü. Ayrıca grupların süt verimleri kıyaslanarak bu değerler ile süt verimi arasındaki ilişki araştırıldı.

Bulgular: Toplam protein seviyesi sırasıyla G3, G2 ve G1 gruplarında daha yüksekti (p<0,001). Benzer şekilde albümin düzeyi G1 Grubuna göre G3 grubunda anlamlı olarak yüksekti (P<0.01). Diğer gruplara göre G1 grubunda glukoz düzeyleri daha yüksek ve kolesterol düzeyleri daha düşük bulundu (p<0,001; p<0,05). AST ve GGT seviyeleri G2 grubuna göre G1 grubunda daha düşük bulundu (p<0.05).

Öneri: Sonuç olarak, süt ineklerinde laktasyon sayısı, total protein, albümin, glukoz, kolesterol, AST ve GGT gibi biyokimyasal parametreleri önemli ölçüde etkilemiştir. Bu farklılıklar Grup 1'e (düveler) göre özellikle multipar ineklerin yer aldığı Grup 2 ve Grup 3'te bulunmuştur.

Anahtar kelimeler: Biyokimyasal parametre, inek, laktasyon sayısı, süt verimi

Abstract

Aim: This study aimed to investigate the relationship between lactation number, milk yield, and some blood biochemical parameters in dairy cows.

Materials and Methods: The material of the study consists of dairy cows (n=60), and three different groups were formed according to the lactation numbers of the cows. Non-lactating heifers were assigned to Group 1 (n=10), 1st and 2nd lactation cows were assigned to Group 2 (n=24), and 3rd and 4th lactation cows were assigned to Group 3 (n=26). The blood total protein, albumin, blood urea nitrogen (BUN) calcium, phosphorus, magnesium, glucose, cholesterol, aspartate transaminase (AST), and gamma-glutamyl transpeptidase (GGT) levels of the cows in the groups were measured. In addition, the milk yields of the groups were compared, and the relationship between these values and milk yield was investigated.

Results: Total protein level was higher in the G3, G2 and G1 groups, respectively (p<0.001). Similarly, albumin levels increased significantly in the G3 group compared to the G1 Group (P<0.01). Glucose and cholesterol levels were higher and lower in G1 group compared to other groups (p<0.001; p<0.05), respectively. AST and GGT levels decreased in the G1 group than in the G2 group (p<0.05).

Conclusion: In conclusion, the number of lactations in dairy cows significantly affected the biochemical parameters within total protein, albumin, glucose, cholesterol, AST and GGT in dairy cows. These differences were found especially in Group 2 and Group 3, which included multiparous cows, compared to Group 1 (heifers).

Keywords: Biochemical parameters, dairy cow, lactation number, milk yield

Introduction

The transition period also called the periparturient period is one of the most interesting stages of the lactation cycle in dairy cows. The length and classification of the period have been defined differently by researchers (Sharma et al 2011). In a broad definition, the transition period is known as the change from gestational non-lactating period to a non-gestational lactating stage in cows (Contreras and Sordillo 2011) and this period is too often a disastrous experience at cow level (Goff and Horst 1997). Generally, the transition period is accepted as 3 or 4 weeks before and after parturition (Contreras and Sordillo 2011, Nowroozi-Asl et al 2016, Duru et al 2021). Though the transition period has a wide range, from 1 week before to 2 weeks after calving has the most significant period in practice. The transition period in cows has attracted the attention of many researchers (Seifi et al 2007, Leblanc 2010, Contreras and Sordillo 2011, Sharma et al 2011, Duru et al 2021). This period is especially critical for health and subsequent yield and fertility performance of dairy cows (Sharma et al 2011). The postpartum period is an important stage in the reproductive life of the cow because it directly affects future fertility and yield (Nazifi et al 2008). Especially dairy cows are more susceptible to infections and metabolic diseases during the periparturient period rather than peak lactation (Sordillo et al 2007).

During the transition period, metabolic and immune functions have sudden changes in cows. These changes are related to increased energy needs due to fetus and lactogenesis (Contreras and Sordillo 2011). It is known that lactation and pregnancy cause stress and alterations in metabolism in dairy cows (Iriadam 2007, Tanritanir et al 2009). At this point, the incidence of some diseases like ketosis, metritis, placental retention, and mastitis elevates (Duru et al 2021), because of sudden changes in both metabolic and immune changes that cows experience (Allen et al 2005, Contreras and Sordillo 2011). These alterations are related to fetal needs, lactogenesis, decrease in dry matter intake and sudden change in hormonal status (Grummer et al 2004, Allen et al 2005). As a result of changes in metabolic and hormonal status, dairy cows experience negative energy balance (NEB) (Leroy et al 2008, Contreras and Sordillo 2011). The period of transition from pregnancy to lactation causes a metabolic challenge to the dairy cow (Piccione et al 2012), so the haemato-chemical profiles are much more important in following the health status of animals and herds (Hagawane et al 2009). At the beginning of lactation, there is a high demand in calcium (Ca) that homeostatic mechanisms must react. Mobilization of Ca and increased absorption from the intestinal tract are critical points that help to establish homeostasis (Liesegang 2008). After delivery, negative energy balance status and alterations in blood metabolite and hormone profiles occur (Wathes et al 2009). All animals require minerals like calcium, magnesium (Mg) and phosphorus (P) for lactation and reproduction (Tanritanir et al 2009, Samardžija et al 2011).

Metabolic and hormonal changes are required for lactation which results in high metabolic output. Therefore, negative energy balance with immunosuppression is inevitable and alterations of the incidence of diseases occur (Oetzel 2004, Mulligan and Doherty 2008). The occurrence of diseases may result in lower milk yield and fertility. Detection of diseases early in cow or herd level is immutable in herd programs. Blood analyses are the first choice to assess cow health status (Huzzey et al 2015, Brscic et al 2015). Different values for different hematological and biochemical analyses have been reported in dairy cows during late pregnancy and post-partum period (Moretti et al 2017). Variations in these values are because of parity, season, lactation number and stage (Cozzi et al 2011, Brscic et al 2015).

The milk yield of dairy cows almost has doubled over the past 40 years. These results increase in metabolic diseases (Oltenacu and Broom 2010, González et al 2011). To assess the health status on herd basis in early post-partum period, the use of blood parameters has been a controversial topic and has been studied intensely. In this manner, following up on the topic with up-to-date information has critical importance. Considering the dairy cow industry is built on economic issues, milk yield and lactation number have special importance as well. The problems of early post-partum period are still not resolved, and period is not clearly understood. Thus, the aim of the presented study is to investigate the relationship between lactation number, milk yield and some blood parameters which are routinely followed in dairy farms.

Material and Methods

Animals

This study was conducted on a large dairy farm in Ankara province of Turkey in fall. Animals were fed with sufficient amount of roughage and concentrate feed and housed in semi-open barns. Body condition score of the heifers were ranging between 2.5-2.75 (over 5) and multiparous cows were 2.75-3.00 (over 5). The present study was carried out on 60 dairy cows in a commercial dairy farm that is free from herd diseases (such as brucellosis and tuberculosis) and, has a free-stall barn system, preventive medicine and vaccination programs are followed, biosafety rules are applied, milking is done 3 times a day with a computerized milking system and herd management is followed by software systems. Cows which were used in this study had no history and signs of clinical health problems and were under the age of five. Cows were undergoing 40-45 days of dry period and 20 days close-up period.

Groups

Three different groups were formed according to the lactation numbers of the cows. Non-lactating (heifers) were assigned to Group 1 (n=10), 1st and 2nd lactation cows were assigned to Group 2 (n=24), and 3rd and 4th lactation cows were assigned to Group 3 (n=26). Three groups of cows with different lactation numbers were created. Since it was aimed to investigate the effect of lactation number, cows in group 2 and 3 were selected to have similar milk yield and age. All animals included in this study had no history of udder health problems and lactating ones had same dry cow therapy.

Samples and Data

This study was conducted based on data from the herd management system. It was aimed to investigate the effect of lactation number on some biochemical parameters which were routinely measured at insemination time in dairy herds. The indicated blood parameters of all groups were routinely measured at the stage of artificial insemination in the farm, and all information used in the study was obtained from farm data. All samples and data were collected by veterinary medicines of the commercial farm. Blood samples were collected on the day of insemination for laboratory analysis and the average milk yield of the cows until the day of insemination was recorded. Since the animals in Group 1 were heifers, milk yield information was not available.

Furthermore, In Group 2 and Group 3, milk records of 2 and 3 cows, respectively, could not be reached. Therefore, these cows were excluded from the milk yield comparison.

Laboratory Analysis

Blood total protein, albumin, blood urea nitrogen (BUN) calcium, phosphorus, magnesium, glucose, cholesterol, aspartate transaminase (AST) and gamma-glutamyl transpeptidase (GGT) levels were analyzed by using an autoanalyzer (ERBA XL 600®).

Statistical analysis

Statistical analyses were performed with SPSS software (IBM; Version 24) using the non-parametric Kruskal-Wallis test. Multiple comparisons were made using Post-hoc Tamhane's T2 test. In addition, the milk yield of Group 2 and Group 3 was compared using Independent-Samples T-Test. All results obtained were presented as median (min-max) and $p<0.05$ was considered statistically significant.

Results

The total protein level was statistically higher in the G3, G2 and G1 groups, respectively ($p<0.001$). Similarly, albumin levels increased significantly in the G3 group compared to the G1 Group ($p<0.01$), but there was a similarity between the G2 and other groups ($p>0.05$). It was also found that the levels of BUN, calcium, phosphorus, and magnesium were similar between G1, G2 and G3 groups ($p> 0.05$). Glucose levels were higher ($p<0.001$), and cholesterol levels were lower ($p<0.05$) in G1 group compared to other groups,

Table 1. Serum Total protein, albumin, BUN, calcium, phosphorus, magnesium, Glucose, Cholesterol, AST/SGOT and GGT concentrations of the G1, G2 and G3 groups

	G1 (n=10)			G2 (n=24)			G3 (n=26)			p Value
	Median	Min	Max	Median	Min	Max	Median	Min	Max	
T.Protein	5.92^{a}	5.55	6.29	7.26^{b}	4.89	8.27	7.67^{c}	6.08	8.37	$^{a-b-c}$p<0.001
Albumin	3.30^{a}	2.06	3.53	3.34^{ab}	2.97	3.94	3.50^{b}	2.52	3.93	$^{a-b}$p<0.05
BUN	8.54	5.69	10.90	10.10	6.96	15.60	10.10	6.37	14.30	p>0.05
Calcium	9.54	8.61	10.20	9.25	8.34	10.20	9.26	8.37	10.10	p>0.05
P	4.75	4.03	6.26	4.46	3.26	7.05	4.47	3.52	6.73	p>0.05
Mg	1.91	1.53	2.18	2.00	1.59	2.45	2.08	1.42	2.49	p>0.05
Glucose	72.00^{a}	71.00	82.00	46.00^{b}	28.00	83.00	47.00^{b}	34.00	71.00	$^{a-b}$p<0.001
Cho	83.00^{a}	68.00	92.00	156.00^{b}	70.00	294.00	176.00^{b}	66.00	284.00	$^{a-b}$p<0.05
AST	79.00^{a}	62.00	99.00	97.5^{b}	64.00	147.00	93.50^{ab}	61.00	138.00	$^{a-b}$p<0.05
GGT	19.00^{a}	15.00	31.00	27.50^{b}	15.00	50.00	26.50^{ab}	14.00	62.00	$^{a-b}$p<0.05

a-c means with different small letters in the same row are significantly different.

Table 2. Milk yields obtained in Group 2 and Group 3

	G1	G2 (n=21) Median (Min-Max)	G3 (n=24) Median (Min-Max)	p Value
Milk Yield (Lt/Day)	0	32.3 (15.4-43.1)	36 (25.8-41.5)	p>0.05

however, there was no difference between the G2 and G3 groups in terms of these values (p>0.05). Moreover, AST and GGT levels decreased significantly in the G1 group than in the G2 group (p<0.05), but no difference was observed in the G3 group compared to G1 and G2 groups (p>0.05). Data of Total protein, Albumin, BUN, calcium, phosphorus, magnesium, Glucose, Cholesterol, AST and GGT levels are presented in detail in Table 1. On the other hand, when the milk yield of the cows in Group 2 and Group 3 were compared, it was determined that there was no statistical difference between the groups. Average milk yields obtained from the groups are presented in Table 2.

Discussion

In the presented study, it was thought that the lactation numbers of dairy cows might affect some blood parameters related to general health and production. To clarify this assumption, 3 groups of cows with different lactation numbers were created. The indicated blood parameters of all groups were routinely measured at the stage of artificial insemination in the farm, and all information used in the study was obtained from farm data.

It was reported that physiological equivalence is controlled by the blood in the body, and differences in hematological parameters are considered as an important reflection of physiological or pathological events in animals (Shil et al 2012, Dar et al, 2019). It is known that some blood biochemical parameters can be used to estimate the physiological, nutritional, metabolic, and clinical status of farm animals (Doornenbal et al 1988, Çolakoğlu et al 2019). It has been stated that blood biochemistry parameters are affected by many variables such as disease, nutritional status (Yazlık et al 2019), seasonal variation (Dar et al 2019), breed, reproductive status, or lactation stage (Doornenbal et al, 1988). In the presented study, animals with similar characteristics and managed under similar conditions were used to eliminate the effect of these variables. Moreover, to optimize the cyclic activity and reproductive status of the animals, all animals were included in the study when they showed estrus and underwent artificial insemination. Our main aim was to evaluate how blood parameters changed as the lactation number of cows in dairy farms increased. Since all blood results were within normal limits, differences in groups cannot be disease related. It is known that biochemical blood parameters such as GGT, AST, ALT, and cholesterol can be used to evaluate metabolic balance and liver functions (Jóźwik et al 2012). Similarly, some blood biochemical parameters can be associated with energy status (Yazlık et al 2019) and reflects a problem in the liver in cows (Kurt et al 2021). In the presented study, it is thought that the differences in biochemical parameters between the groups are not affected by nutrition or disease status, since animals were healthy, fed according to their stage and had similar characteristics. Already, no difference was observed between the groups in terms of BUN, calcium, phosphorus, and magnesium in this study. Thus, it is thought that these parameters are not affected by the number of lactations. However, although there was no difference between Group 2 and Group 3 in terms of albumin, glucose, cholesterol, AST and GGT, the number of lactations significantly affected the concentration of total protein, albumin, glucose, cholesterol, AST and GGT in the other groups compared to Group 1. When these parameters, which are affected by the number of lactations, are examined, it is revealed that while glucose decreases, all other parameters increase. Therefore, it is estimated that the biochemical parameters that differ between the groups in the presented study are affected by the number of lactations. It is known that lactation number affects milk yield (Eşki and Kurt 2021) The reason for the difference between group 2 and group 3 compared to group 1 was thought to be lactation and milk yield as there were heifers in group 1. It is known that blood biochemical parameters can be affected by milk yield as well (Jóźwik et al 2012, Naser et al 2014). Though it looks like some biochemical parameters were affected by lactation number, it is thought that this situation is most likely due to the metabolic load created by the milk yield in the liver. However, milk yield was found to be similar between the groups in this study. Since cows were not grouped separately according to their milk yield in this study, it was thought that the existence of this relationship could not be determined exactly.

Conclusion

In conclusion, the number of lactations in dairy cows significantly affected the biochemical parameters within the total protein, albumin, glucose, cholesterol, AST and GGT in dairy cows. These differences were found especially in Group 2 and Group 3, which included multiparous cows, compared to Group 1 (heifers). In this case, it was thought that lactation number may affect blood biochemical parameters, and cows with high milk yield are even more sensitive to changes in

biochemical values. Furthermore, in this presented study, milk yield was similar between Group 2 and Group 3, but many biochemical parameters were already found to be similar between these groups. However, this effect needs to be investigated more comprehensively with further studies

Conflict of Interest

The authors did not report any conflict of interest or financial support.

Funding

During this study, any pharmaceutical company which has a direct connection with the research subject, a company that provides and / or manufactures medical instruments, equipment and materials or any commercial company may have a negative impact on the decision to be made during the evaluation process of the study or no moral support.

References

Allen MS, Bradford BJ, Harvatine KJ, 2005. The cow as a model to study food intake regulation. Annu Rev Nutr, 25, 523–547.

Brscic M, Cozzi G, Lora I, et al., 2015. Short communication: Reference limits for blood analytes in Holstein late-pregnant heifers and dry cows: Effects of parity, days relative to calving, and season. J Dairy Sci, 98, 7886–7892.

Çolakoğlu HE, Yazlık MO, Pekcan, M, Kaya, U et al., 2019. Impact of prepartum body condition score loss on metabolic status during the transition period and subsequent fertility in Brown Swiss dairy cows. J Vet Res, 63(3), 375-382.

Contreras GA, Sordillo LM, 2011. Lipid mobilization and inflammatory responses during the transition period of dairy cows. Comp Immunol Microbiol Infect Dis, 34, 281–289.

Cozzi G, Ravarotto L, Gottardo F, et al., 2011. Short communication: Reference values for blood parameters in Holstein dairy cows: Effects of parity, stage of lactation, and season of production. J Dairy Sci, 94, 3895–3901.

Dar AH, Kumar S, Singh DV, Sodhi M et al., 2019. Seasonal variation in blood biochemical characteristics of Badri cattle. Pharma Innov, 8(9), 147-150.

Doornenbal, H, Tong AK, Murray NL, 1988. Reference values of blood parameters in beef cattle of different ages and stages of lactation. Can J Vet Res, 52(1), 99.

Duru Ö, Devrim AK, Macun HC et al., 2021. The relationship of leptin and thyroid hormones with milk yield and some fertility parameters in Simmental dairy cows during transition period. Turkish J Vet Anim Sci, 45, 1065–1073.

Eşki F, Kurt S, 2021. Effect of lactation number on milk yield in Holstein dairy cows. TJVR, 5(1), 1-4.

Goff JP, Horst RL, 1997. Physiological changes at parturition and their relationship to metabolic disorders. J Dairy Sci, 80, 1260–1268.

González FD, Muiño R, Pereira V et al., 2011. Relationship among blood indicators of lipomobilization and hepatic function during early lactation in high-yielding dairy cows. J Vet Sci, 12, 251–255.

Grummer RR, Mashek DG, Hayirli A, 2004. Dry matter intake and energy balance in the transition period. Vet Clin Food Anim Pract, 20, 447–470.

Hagawane SD, Shinde SB, Rajguru DN, 2009. Haematological and blood biochemical profile in lactating buffaloes in and around Parbhani city. Vet World 2:467–469.

Huzzey JM, Mann S, Nydam DV et al., 2015. Associations of peripartum markers of stress and inflammation with milk yield and reproductive performance in Holstein dairy cows. Prev Vet Med, 120, 291–297.

Iriadam M, 2007 Variation in certain hematological and biochemical parameters during the peri-partum period in Kilis does. Small Rumin Res, 73, 54–57.

Jóźwik A, Strzałkowska N, Bagnicka E, Grzybek W et al., 2012. Relationship between milk yield, stage of lactation, and some blood serum metabolic parameters of dairy cows. Czech J Anim Sci, 57(8), 353-360.

Kurt S, Eşki F, Demir PA, 2021. Investigation of Repeat Breeder Status, Fertility Success and Some Blood Parameters in Healthy, Follicular, and Luteal Cystic Cows. Atatürk Üniv Vet Bilim Derg, 16(3), 313-319.

Leblanc S, 2010. Monitoring metabolic health of dairy cattle in the transition period introduction—metabolic challenges in peripartum dairy cows and their associations with reproduction. J Reprod Dev Reprod Dev, 56, 29–35.

Leroy J, Vanholder T, Van Knegsel ATM et al., 2008. Nutrient prioritization in dairy cows early postpartum: mismatch between metabolism and fertility? Reprod Domest Anim, 43, 96–103.

Liesegang A, 2008. Influence of anionic salts on bone metabolism in periparturient dairy goats and sheep. J Dairy Sci, 91, 2449–2460.

Moretti P, Paltrinieri S, Trevisi E et al., 2017. Reference intervals for hematological and biochemical parameters, acute phase proteins and markers of oxidation in Holstein dairy cows around 3 and 30 days after calving. Res Vet Sci, 114, 322–331.

Mulligan FJ, Doherty ML, 2008. Production diseases of the transition cow. Vet J, 176, 3–9.

Naser EM, Mohamed G, Elsayed H, 2014. Effect of lactation stages on some blood serum biochemical Parameters and milk composition in dairy cows. Assiut Vet Med J, 60(142), 83-88.

Nazifi S, Ahmadi MR, Gheisari HR, 2008. Hematological changes of dairy cows in postpartum period and early pregnancy. Comp Clin Path, 17, 157–163.

Nowroozi-Asl A, Aarabi N, Rowshan-Ghasrodashti A, 2016. Ghrelin and its correlation with leptin, energy related metabolites and thyroidal hormones in dairy cows in transitional period. Pol J Vet Sci, 19(1), 197-204.

Oetzel GR, 2004. Monitoring and testing dairy herds for metabolic disease. Vet Clin North Am Food Anim Pract, 20, 651–674.

Oltenacu PA, Broom DM, 2010. The impact of genetic selection for increased milk yield on the welfare of dairy cows. Anim Welf, 19, 39–49.

Piccione G, Messina V, Marafioti S et al., 2012. Changes of some haematochemical parameters in dairy cows during late gestation, post partum, lactation and dry periods. Vet ir Zootech, 58, 59–64.

Roubies N, Panousis N, Fytianou A, Katsoulos PD et al., 2006. Effects of age and reproductive stage on certain serum biochemical parameters of Chios sheep under Greek rearing conditions. J Vet Med A, 53(6), 277-281.

Samardžija M, Dobranić T, Lipar M et al., 2011. Comparison of blood serum macromineral concentrations in meat and dairy goats during puerperium. Vet Arh, 81, 1–11.

Seifi HA, Gorji-Dooz M, Mohri M et al., 2007. Variations of energy-related biochemical metabolites during transition period in dairy cows. Comp Clin Path, 16, 253–258.

Sharma N, Singh NK, Singh OP et al., 2011. Oxidative stress and antioxidant status during transition period in dairy cows. Asian-Australasian J Anim Sci, 24, 479–484.

Shil SK, Shaikat AH, Nath BK, Khan MFH et al., 2012. Hemato-biochemical profile in lactating cows and their calves. J Bangladesh Soc Agric Sci Technol, 9(1&2), 41-44.

Sordillo LM, O'boyle N, Gandy JC et al., 2007. Shifts in thioredoxin reductase activity and oxidant status in mononuclear cells obtained from transition dairy cattle. J Dairy Sci, 90, 1186–1192.

Tanritanir P, Dede S, Ceylan E, 2009. Changes in some macro minerals and biochemical parameters in female healthy Siirt hair goats before and after parturation. J Anim Vet Adv, 8, 530–533

Wathes DC, Cheng Z, Chowdhury W et al., 2009. Negative energy balance alters global gene expression and immune responses in the uterus of postpartum dairy cows. Physiol Genomics, 39, 1–13.

Yazlık MO, Çolakoğlu HE, Pekcan M, Kaya U et al., 2019. The evaluation of superoxide dismutase activity, neutrophil function, and metabolic profile in cows with retained placenta. Theriogenology, 128, 40-46.

Author Contributions

Motivation / Concept: Taha Burak Elifoglu, Serdal Kurt
Design: Taha Burak Elifoglu, Serdal Kurt
Control/Supervision: Taha Burak Elifoglu, Serdal Kurt
Data Collection and / or Processing: Taha Burak Elifoglu, Serdal Kurt
Literature Review: Taha Burak Elifoglu, Serdal Kurt
Writing the Article: Taha Burak Elifoglu, Serdal Kurt
Critical Review: Taha Burak Elifoglu, Serdal Kurt

Ethical Approval

Kirikkale University, Local Ethical Committee 22.08.2022, E-60821397-10.99-113709 Numbered Ethics Committee Decision

CITE THIS ARTICLE: *Elifoglu TB, Kurt S, 2022. Effect of lactation number on some biochemical parameters in postpartum dairy cows. Eurasian J Vet Sci, 38, 4, 248-253.*