# Determination of backfat thickness with transrectal ultrasonography in cattle

# Sığır sırt yağ kalınlığının transrektal ultrasonografik muayene yöntemi ile belirlenmesi

**Research Article**

**Hasan Atalay [1]**
**Erdem Danyer[2]**
**Tanay Bilal[3]**
**Mikail Arslan[4]**
**Sinan Toksavul[5]**
**Kudret Yenilmez[6]**
**Hüdai İpek[7]**

[1] Balikesir University Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, 10145, Balıkesir, TURKEY ORCİD: 0000-0002-5744-7538
[2] Parasitology Laboratory, Veterinary Control Central Research Institute, 06200, Ankara –TURKEY ORCİD:0000-0002-7922-7384
[3] Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, Istanbul-Cerrahpasa, University 34320 Istanbul-TURKEY ORCİD:0000-0001-7258-6862
[4] Susurluk Vocational School of Higher Education, Balikesir University, 10600, Balikesir-TURKEY ORCİD: 0000-0002-7882-9586
[5] Bilcanlı Livestock Establishment. Şamlı Village Balıkesir-TURKEY ORCİD:0000-0002-2358-0314
[6] Namık Kemal University Department of Obstetric and Gynecology, Faculty of Veterinary Medicine, 59030, Tekirdağ, TURKEY ORCİD:0000-0002-5532-0525
[7] Aksaray University Department of Physiology, Faculty of Veterinary Medicine, Aksaray, TURKEY ORCİD:0000-0003-3148-571X

***Correspondence***
**Hasan Atalay**
hasanatalay@balikesir.edu.tr,
Phone: +902666136692/346,
Fax: +902666136657

***Article info***
Submission: 02-04-2019
Accepted: 17-03-2019
Online published: 28-04-2019

## ABSTRACT

The purpose of this study is to determine the Body Condition Score (BCS), which is subjectively measured in dairy cattle with inspection and palpation of backfat thickness, objectively by using transrectal ultrasonography examination method after delivery. Forty-four cows, randomly selected from 350 dairy cattle with average 650 kg live weight and 2 - 6 lactation number have been used. Cows have been separated in two groups according to BCS; which are: Group 1 (BCS ≤ 3) 22 cows ("V" shape observed upon lateral view of pelvis, BCS equal to or below 3) and Group 2 (BCS > 3) 22 cows ("U" shape observed upon lateral view of pelvis, BCS above 3). Subcutaneous fat thickness have been determined by examining body thickness using ultrasonographic imaging above the skin. In this study, ultrasonographic images were obtained by transrectal ultrasound examination method for the first time, and backfat thickness was determined and presented for literature. In the transrectal ultrasound examination; A hand-held probe was inserted from the rectum after rectum is cleared, it was pushed forward inside the cavum pelvis, and measurements were performed on the fat tissue between the muscle and skin layers by scanning vertically using the probe on the sacral region between the upper parts of last lumbar vertebrae, sacrum and tuber coxae. Corresponding images resulting from the examination were saved on the ultrasonography device, and evaluated after being transferred in software. In result of this study, backfat thickness of BCS ≤ 3 and BCS > 3 groups were determined according to ultrasonography examination method, and a difference was observed between groups (p<0,05). TMR (Total Mixed Ration) analysis had been done. In this study 305-day milk yields have been determined and no difference has been determined between groups (p>0,05).

**Key Words:** Body Condition Score (BCS), Ultrasound, Transition Period

## ÖZET

Sunulan çalışmanın amacı, süt sığırlarında sırt yağ kalınlığını inspeksiyon ve palpasyonla subjektif olarak ölçülerek yapılan Vücut Kondisyon Skor (VKS) tespitini, doğum sonrası transrektal ultrasonografi muayene yöntemi ile objektif olarak belirlemektir. İşletmedeki 350 adet süt sığırı içerisinden ortalama 650 kg canlı ağırlıkta, 2-6. laktasyonda rastgele seçilen 44 adet inek kullanılmıştır. İnekler VKS'una göre; 1. grup (VKS ≤ 3) 22 inek (Pelvis bölgesine yandan bakıldığında VKS'nun 3 veya 3'ün altında olduğunda "V" şeklinin görülmesi) ve 2. grup (VKS > 3) 22 inek (Pelvis bölgesine yandan bakıldığında VKS' nun 3' ün üstünde olduğunda "U" şeklinin görülmesi) olmak üzere inekler iki gruba ayrılmıştır. Deri altı yağ kalınlığı derinin üstünden ultrasonografik görüntü elde edilerek vücut yağlılığı ile ilgili bilgiler elde edilmektedir. Bu çalışmada ilk kez transrektal ultrason muayene yöntemi ile ultrasonografik görüntü elde edilmiş, sırt yağ kalınlığı tespit edilmiş ve literatüre sunulmuştur. Transrektal ultrason muayenesinde; avuç içine alınan prob, rektumdan içeriye sokularak, rektumun boşaltılması, cavum pelvis içinde ilerletilerek son bel omurları, sakrum ve tuber coxa'ların üst kısımları arasında kalan sakral bölge prob ile dikey taranarak, kas ile deri tabakası arasındaki yağ dokusu tespit edilerek ölçümler yapılmıştır. Muayene sonucu elde edilen uygun görüntüler ultrasonografi cihazına kaydedilmiş ve bilgisayar ortamına aktarılarak değerlendirilmiştir. Bu çalışmanın sonucunda, VKS ≤ 3 ve VKS > 3 gruplarının sırt yağ kalınlığı ultrasonografi muayenesiyle belirlenmiştir ve gruplar arasında farklılık önemli bulunmuştur (p<0,05). TMR (Toplam Karma Yem) analizi yapılmıştır. Bu çalışmada 305 günlük süt verimi belirlenmiştir ve gruplar arasında fark görülmemiştir (p>0,05).

**Anahtar Kelimeler:** Vücut Kondisyon Skoru (VKS), Ultrason, Geçiş Dönemi

***How to cite this article***

**Atalay H, Danyer E, Bilal T, Arslan M, Toksavul S, Yenilmez K, İpek H (2019).** Determination of backfat thickness with transrectal ultrasonography in cattle. *J Adv VetBio Sci Tech.* 4(1): 16-21. DOI: http://doi.org/10.31797/vetbio.548423



**e-ISSN:** 2548-1150
**website**: http://dergipark.gov.tr/vetbio
**doi prefix:** 10.31797/vetbio.

## INTRODUCTION

Body Condition Score (BCS) determination, which has been performed with inspection and palpation for years, now can be performed more objectively using technological developments. In the conventional method, backfat thickness is determined directly by using a portable, hand-held ultrasound device and measuring the amount of fat stored between skin and muscle tissue. The fat stored in high-yield dairy cows in the dry period is used for milk production by mobilization from tissues at the beginning of lactation. A Body Condition Scoring system is used in dairy cattle breeding that is increased one point at every 0.25 interval with a scale between 1 and 5 or 1 and 9. The scores given for BCS refer to the amount of fat determined in the body. A cow, BCS of which is 3 has 122 kg of body fat, while another cow with BCS of 3.5 has 146 kg of body fat (Çitil and Uzlu, 2005; Edmenson et al. 1989).

In early lactation (postpartum period), limited dry matter consumption falls behind the rapidly-increasing milk yield, and the cow drifts into negative energy balance with increased acceleration. The energy gap resulting from milk yield is compensated by body fat mobilization. Increased milk yield causes the mobilization of more body fat and a decrease in BCS. Risk of nutritional diseases is increased in high-yield cows under the pressure of negative energy (Schroeder and Staufenbiel, 2006).

Each point lost in BCS is equivalent to 400 Mcal of energy. Since 1 point-decrease in BCS is equal to 56 kg of body weight, 1 kg of body weight is equal to 400/ 56 = 7.14 Mcal of energy. 400 Mcal body energy is equal to 545 kg of milk yield. 10 kg of milk is obtained by 1 kg body fat mobilization (Ferguson, 1996).

BCS is affected by the amount of nutrients spent on milk production and energy obtained from ration. Fat stored in body tissues are called as body fat reserves. Nutrition and metabolism diseases, difficult calving, decreased milk yield and infertility problems are experienced when cows are extremely fat or thin. BCS is used in order to estimate the body composition. Therefore, BCS is correlated with body composition, body fat ratio and energy content. Systems numbered from 1 to 5, or 1 to 9 are used for balance between body composition and BCS. 1 kg of fat in the body average 9.4 Mcal energy 1 kg of protein equals 5.55 Mcal energy. It is reported that 5.47 Mcal/ kg energy is released when BCS falls from 3 to 2.1 point this means an extremely thin cow and 5 points means an extremely fat cow in 5-point system. The decreasing expected in BCS is between 0.5 and 1 in the transition period. 1-point decrease in BCS provides 417 Mcal NEL (net energy in lactation) in a 650-kg cow, and this energy supports 564 kg of milk yield. In order to have positive balance of energy during the first 3 weeks of lactation, BCS should be between 2.5 – 3.75 in the transition period. (Ferguson, 1996; NRC, 2001).

In this study, ultrasonographic images were obtained by transrectal ultrasound examination method for the first time, and backfat thickness, milk yield was determined and connection with BCS is discussed.

## MATERIALS AND METHODS

*Ethics Statement:* The approval of experimental animal local ethics committee dated 12.03.2018 nr. 2018/5 has been obtained from Veterinary Control Central Research Institute.

*Animals and Body Condition Scoring:* Forty-four Holstein-Friesian cattle from a commercially licensed dairy establishment within Balıkesir province, which were selected from 350 cows with average 650 kg live weight and 2 – 6 lactation number, have been used in this study. All the cows in the study have been fed with the same Total Mixed Ration (TMR) and BSC was determined with inspection and palpation in the first 5 days after calving. In general, fat thickness is determined by using direct ultrasound and ultrasonographic images. In this study, according to BCS assessment, cows are separated in two groups as Group 1 (BCS $\leq$ 3.00) and Group 2 (BCS >3.00). Scoring of BCS is performed by manual palpation and visual inspection. Upon lateral view of the pelvis, observing "V" and "U" shapes in the line between Tuber coxae-Tuber ischii is important for the determination of the score. Observing a "U" shape means that BCS value is above 3 (BCS > 3, group 2), and observing a "V" shape means that BCS value is equal to or below 3 (BCS ≤ 3, group 1). "U" and "V" shapes in the pelvis are shown in Figure 1.

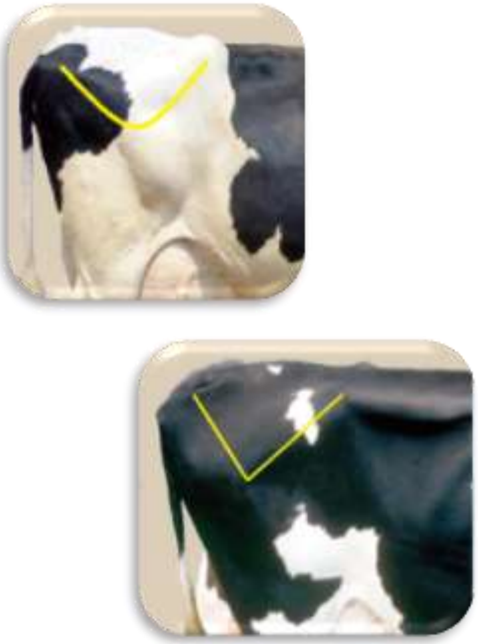

**Figure 1.** Upon lateral view of the pelvis "V" shapes (group 1) and "U" shapes (group 2) in the line between Tuber coxae-Tuber ischii.

*Transrectal ultrasonography analysis:* In transrectal ultrasonography method, a hand-held probe is inserted from the rectum and backfat thickness is determined by measuring the fat thickness between fasciae through scanning vertically on the sacral region between the upper parts of last lumbar vertebrae, sacrum and Tuber coxae. There are gluteal muscles and longissimus dorsi muscles below deep fascia, there is the skin above superficial fasciae, and fat layers are present between those fasciae. There are gluteal muscles in points contacted by the probe, fat tissue above those, and skin on the top. In this study, a 7.5 MHz, real-time Linear Probe (Rectal) hand-held veterinary ultrasonography device (Honda Electronics Co., Ltd., HS-1600) has been used (Çitil and Uzlu, 2005; Schroeder and Staufenbiel, 2006). The high-frequency sound waves emitted from the device and reflected by the different density of tissues (skin, fascia, muscles, adipose tissue) was captured as images in the ultrasound, and the thickness of fat layer was measured in millimeters (Çitil and Uzlu, 2005; Schroeder and Staufenbiel, 2006). Fat thicknesses measured as per transrectal ultrasound examination method are demonstrated according to literatures in Figure 2, 3.

**Figure 2.** Transrectal ultrasonographic fat thickness (25.9 mm) in a Holstein-Friesian cow with BCS=3.25 (group 2) (57-months) on Postpartum Day 0–5 in the transition period

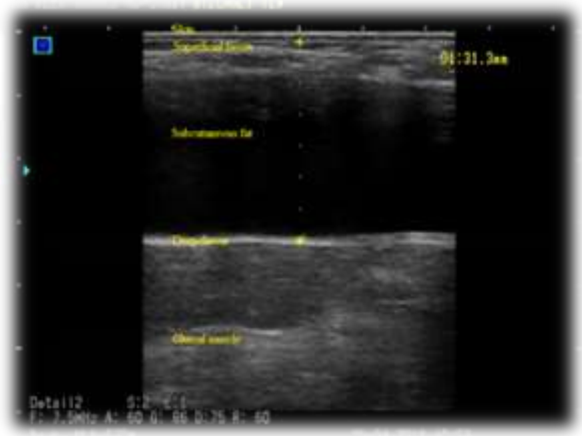

**Figure 3.** Transrectal ultrasonographic fat thickness (31.3 mm) in a Holstein-Friesian cow with BCS=3.25 (group 2) (43-months) on Postpartum Day 0–5 in the transition period

*Statistical Analyses:* IBM® SPSS® (V. 21, Armonk, NY, USA) program was used for the analysis of the data determined throughout the study. Normal distribution in results was controlled with Shapiro-Wilk test, while homogeneous distribution of variances was controlled with Levene's test. A simple linear regression analysis was used for examining the relation between BCS assessment and transrectal ultrasound measurement of fat thickness. Furthermore, mean difference between the two groups was determined with independent samples t-test. The results have been reported as mean group values and mean standard error, and statistical significance limit was assumed as $p \leq 0.05$ for all statistical analyses (Kus and Keskin, 2008; Özdamar, 2015; Sümbüloğlu and Sümbüloğlu, 2016).

**Table 1.** The distribution of mean backfat thickness (mm) and standard deviation (SD) according to determined BCS values.

| BCS | Mean Fat Thickness (mm) | SD |
|---|---|---|
| **2.5 *(n:5)*** | 17.84 | 1.44 |
| **2.75 *(n:9)*** | 25.10 | 1.57 |
| **3 *(n:8)*** | 29.51 | 1.31 |
| **3.25 *(n:11)*** | 30.46 | 1.50 |
| **3.5 *(n:3)*** | 32.27 | 2.00 |
| **3.75 *(n:4)*** | 35.33 | 1.36 |
| **4.25 *(n:2)*** | 41.55 | 1.25 |
| **4.5 *(n:2)*** | 45.60 | 0.10 |

## RESULTS

The distribution of mean backfat thickness (mm) according to determined BCS values are presented in Table 1, and comparison of backfat thickness values in between groups are presented in Table 2. Mean values were compared for the two groups, and mean backfat thickness values were determined to be different in the two groups ($p < 0.001$) (Table-2).

**Table 2.** Comparison of backfat thickness values in between groups

| Groups | Mean Value (mm) | Mean Standard Error | *t value* | *P value* |
|---|---|---|---|---|
| **Group1 (BCS≤3) (n:22)** | 25.05 | 1.01 | -5.92 | <0.001* |
| **Group 2 (BCS>3.00) (n:22)** | 33.97 | 1.13 | | |

*****The difference between the groups is significant.

Upon controlling the correlation between backfat thickness determined in ultrasound measurement and BCS determined with Pearson's correlation coefficient test, r value was calculated as 0.94 and 0.95, respectively, for BCS $\leq$ 3 and BCS > 3.00 groups ($p < 0.001$) (Table-3).

**Table 3.** Pearson's correlation coefficient (r) for examining the relation between groups and backfat thickness determined with ultrasound.

| Groups | R | *P value* |
|---|---|---|
| **Group 1 (BCS≤3) (n:22)** | 0.94 | <0.001* |
| **Group 2 (BCS>3.00) (n:22)** | 0.95 | |

*****The difference between these relations is significant.

The contents of TMR and nutrient composition were determined in Balıkesir University, Veterinary Faculty, Animal Nutrition and Nutritional Diseases laboratory according to the methods indicated in AOAC (1998).

**Table 4.** Nutrient composition of TMR (DM %)

| DM (dry matter) % | 53,21 |
|---|---|
| **CP % (Crude protein)** | 17,39 |
| **EE % (Ether extract)** | 4,79 |
| **CC % ( Crude cellulose)** | 14,68 |
| **CA % (Crude ash)** | 7,20 |
| **Nitrogen-free extract** | 9,15 |
| **Starch %** | 29,89 |

The contents of TMR and nutrient composition were determined and have been presented in Table 4. 305-day milk amounts have been determined between the groups and presented in Table 5 and no difference has been observed between the groups ($p > 0.05$). According to results in group 1 mean milk yield was calculated 8021.5 and in group 2 mean milk yield was observed as 8679.36 ($p > 0.05$).

**Table 5.** Comparison of 305-day milk yield between the groups.

| Group | Mean Value | Standard Errors Mean | *P value* |
|---|---|---|---|
| **Group 1 (BCS≤3) (n:22)** | 8021.5 | 509.54 | 0.39 |
| **Group 2 (BCS>3.00) (n:22)** | 8679.36 | 565.93 | |

## DISCUSSION

It has been stated that direct ultrasound measurements of backfat thickness is between 8 - 40 mm in cows in the first postpartum week (Hussein et al., 2013). Although mean backfat thickness is 51 mm in Simmental cows, it was stated that backfat thickness is 35 mm in Holstein cows. No association has been reported between milk yield and BCS (Schäfers, 2000). Backfat thickness should be between 20-25 mm in the dry period and cows should maintain this level of backfat thickness throughout dry period. At the beginning of the preparation period, BCS was determined to decrease as a result of lipid mobilization in body fat tissues. Sufficient fat storage has a positive effect on milk yield and reproduction performance. Increased level of ketone bodies is an unfavorable state in cows with good condition. Greater mobilization of fat tissue in the transition period poses a negative effect of dry matter consumption, and this is stated to change the blood levels of the animal (Daetz, 2009).

In direct ultrasound measurements, backfat thickness in cows with BCS ≤ 3 (very poor body condition – good body condition) was determined to be below 20 mm, while it was determined to be between 20 mm to 35 mm and above in cows with BCS > 3 (good body condition – very fat body condition). The amount of fat in the body was below 122 kg in cows with BCS ≤ 3, and between 122-194 kg in cows with BCS > 3 (Çitil and Uzlu, 2005; Edmenson et al., 1989).

Four cows with BCS ≤ 3 received help in birth. In a study performed with 134 cows investigating the effects of low BCS and narrow birth canal on difficult labor, it was concluded that these parameters had 12% effect on difficult labor (Wesley, 2002). In another study investigating the factors resulting in difficult labor in cattle, it was stated that pelvic area was a distinctive factor for difficult labor in Herford and Angus cows and it posed higher significance than BCS as a determining factor (Zaborski et al., 2009). No association was determined between BCS and difficult labor in a 15-year study performed on 2384 cows (Berry et al., 2007). Low BCS and negative energy level are also considered to cause difficult labor. However, no significant association has been observed between BCS values and difficult labor as it can be seen from the results of our study. It has been stated that there is a significant link between haematocrit, MCV, MCHC and neutrophil values and difficult labor (Yıldız et al., 2011).

While no retained placenta was observed in BCS ≤ 3 group, it was observed in three cows (13.64%) in the other (BCS > 3) group. In a study investigating the relation between retained placenta and BCS, retained placenta was observed in BCS > 3 cows in parallel with our results, and as a result it has been recommended to avoid fattening nutrition styles in the dry period (Zonturlu et al., 2008).

It has been stated that the prevalence of mastitis is increased due to immune system suppression in cows with high BCS resulting from faster weight loss and ketosis after calving (Valde et al., 2007). This statement is in parallel with our study since low BCS group experienced 50% less mastitis in our study. In a study investigating the relation between subclinical mastitis and BCS, no statistically significant difference was determined in terms of subclinical mastitis rate in cows separated in three groups according to BCS (Atasever and Erdem, 2009).

Abomasal displacement was only observed in one cow from each group in our study. It has been reported that high BCS may cause abomasal displacement in cows (Sen et al., 2015; Cameron et al., 1998). In a study performed on 732 cows, it has been determined that 2.5-fold higher ketone bodies were formed in cows with BCS < 3.5 during delivery (Gillund et al., 2001).

It has been stated that cows with extreme condition, cows with BCS > 3.5 and cows with backfat thickness higher than 26 mm enter negative energy level, and they are prone to nutritional diseases in the transition period. It has also been stated that inflammatory state of the liver has a tendency to increase nutritional diseases in transition period alone and/or with other nutritional diseases (Hayırlı et al., 2016).

Although the visual and manual palpation methods for the determination of BCS give a general idea, it is recommended to perform this measurement with ultrasound in order to obtain objective data. A significant parallelism was determined between BCS and backfat thickness determined with direct ultrasound in a study performed on cows with BCS between 2.5 and 4.5. A significant different was determined between BCS ≤ 3 and BCS > 3.00 groups with regard to backfat amount (Hussein et al., 2013).

## CONCLUSION

As a result, body fat is mobilized since the energy requirement in the postpartum period is not met with feed, and changes are observed in BCS for this reason. Knowing the level of body fat at calving provides information on the amount of energy stored in the body. Waist to thigh fat thickness was determined with real time transrectal ultrasonography method. Determined fat thickness was compared with body condition score, and waist to thigh fat thickness and the level of fat stored in the body were found with the determined BCS level. Since 80% of cows in the transition period are in the negative energy balance, changes in BCS provide information about the level of mobilized and stored fat.

## REFERENCES

**AOAC (1998)** Official Methods of Analysis (16th Edition) Association of Anallytical Chemist Vols. I and II, Revision. Gait hersburg, Maryland; 20877-2417 USA

**Atasever, S., Erdem H. (2009).** Association between subclinical mastitis markers and body condition scores of Holstein cows in the Black Sea region, *Turkey. J Anim Vet Adv*, 8: 476-480.

**Berry, D.P., Lee, J.M., Macdonald, K.A., Roche, J.R. (2007).** Body condition score and body weight effects on dystocia and stillbirths and consequent effects on postcalving performance. *J Dairy Sci*, 90: 4201-4211, DOI:10.3168/jds.2007-0023

**Cameron, R.E.B., Dyk, P.B., Herdt, T.H., Kaneene, J.B., Miller, R., Bucholtz, H.F., Liesman, J.S., Vandehaar, M.J., Emery, R.S. (1998).** Dry cow diet, management, and energy balance as risk factors for displaced abomasum in high producing dairy herds. *J Dairy Sci*, 81: 132-139, 1998. DOI:10.3168/jds.S0022-0302(98)75560-2

**Çitil, M., Uzlu, E. (2005)** Die Bedeurteilung der Körperkondition mit Hilfe des Ultraschalls bei der Frühdiagnose der Postpartaten Erkrankungen bei Milchkuh. *Kafkas Univ Vet Fak Derg*, 11: 201-206.

**Daetz, C. (2009)** Untersuchungen zur Konditionsentwicklung bei Milchkühen in der Trockenstehperiode mittels ultrasonographischer Messung der Rückenfettdicke und deren Einfluss auf Leistung, Fruchtbarkeit und Tiergesundheit in der Frühlaktation, Inaugural-Dissertation zur Erlangung des Grades eines Doktors der Veterinärmedizin an der Freien Universität Berlin, https://d-nb.info/1024541932/34, Date of access: 06.10.2018.

**Edmenson, A.J., Lean, I.J., Wear, L.D., Farver, T., Webster, G. (1989)** A body condition scoring chart for holstein dairy cows. *J Dairy Sci*, 72: 68-78, DOI: https://doi.org/10.3168/jds.S0022-0302(89)79081-0.

**Ferguson, J.D. (1996)** Implementation of a body condition scoring programme in dairy herd. Proceeding of the Penn Conference. University of Pennsylvania, School of Veterinary Medicine, www.vet.upenn.edu. Date of access: 10.08.2018.

**Gillund, P., Reksen, O., Gröhn, Y.T., Karlberg, K. (2001).** Body condition related to ketosis and reproductive performance in Norwegian dairy cows. *J Dairy Sci*, 84: 1390-1396, DOI:10.3168/jds.S0022-0302(01)70170-1.

**Hayırlı, A., Dogan, V., Kaynar, O., Cengiz, M., Balli, B. (2016)** Evaluation of Peripartum Prognostic and Diagnostic Markers in Dairy Cattle. *Turkiye Klinikleri J Vet Sci*, 2: 63-80.

**Hussein, H.A., Westphalb, A., Staufenbiel, R. (2013).** Relationship between body condition score and ultrasound measurement of backfat thickness in multiparous Holstein dairy cows at different production phases. *Australian Vet J*, 91: 185-189, DOI:10.1111/avj.12033.

**Kus, C., Keskin, I. (2008).** A study on levene and bartlett tests. *Selcuk Tar Gida Bil Derg*, 22: 78-83.

**NRC (National Research Council) (2001).** Nutrient Requirements of dairy cattle. Washington DC: National Academies Press,

**Özdamar, K. (2015).** Biostatistics with SPSS (10th ed.). Eskisehir: Nisan Kitabevi Yayınları.

**Schäfers, M. (2000).** Untersuchungen zur Körperkonditionsbeurteilung bei Milchkühen der Rasse “Fleckvieh” unter den Haltungsbedingungen des nördlichen Oberbayerns, Inaugural-Dissertation zur Erlangung der tiermedizinischen Doktorwürde der Tierärztlichen Fakultät der Ludwig-Maximilians-UniversitätMünchen,https://edoc.ub.unimuenchen.de/17560/1/Schaefers Matthias.pdf., Date of access: 05.10.2018.

**Schroeder, U.J., Staufenbiel, R. (2006).** Invited review: methods to determine body fat reserves in dairy cow with special regard to ultrasonographic measurement of backfat thickness. *J Dairy Sci*, 89, 1-14, DOI:10.3168/jds.S0022-0302(06)72064-1.

**Sen, I., Wittek, T., Guzelbektes, H. (2015).** Metabolic indicators and risk factors of left displaced abomasum in dairy cattle. Eurasian J Vet Sci, 31: 63-69.

**Sümbüloglu, K., Sümbüloglu, V. (2016)** Biyoistatistik /17.ed.) Hatipoğlu yayınevi, Ankara

**Valde, J.P., Lystad, M.L., Simensen, E., Østerås, O. (2007).** Comparison of feeding management and body condition of dairy cows in herds with low and high mastitis rates. *J Dairy Sci*, 90: 4317-4324, DOI:10.3168/jds.2007-0129.

**Wesley, A.M. (2002).** The relationship between prepartum dietary energy intake and pelvic area on dystocia. Texas A&M University PhD Dissertation. Texas, USA.

**Yıldız, H., Saat, N., Simsek, H. (2011).** An investigation on body condition score, body weight, calf weight and hematological profile in crossbred dairy cows suffering from dystocia. *Pak Vet J*, 31: 125-128.

**Zaborski, D. Grzesiak, W., Szatkowska, I., Dybus, A., Muszynska, M., Jedrzejczak, M. (2009).** Factors affecting dystocia in cattle. *Reprod Domest Anim*, 44: 540-551, DOI:10.1111/j.1439-0531.2008.01123.x.

**Zonturlu, A.K., Uren, N., Ozyurtlu, N., Bozkurt, G., Alpaslan, B.M. (2008)** Comparison of Ages, Milk yield, Body Condition Score (BCS) and Serum Selenium Levels in Cows with Retained Placenta. *FU Sag Bil Derg*, 22: 127-130.