The Effects of Drinking Water Treated with Energized Oxygen on Fattening Performance in Beef Cattle

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Abstract: This study was conducted to determine the potential effects of drinking water enriched with oxygen on fattening performance and dressing percentages of cattle in a commercial beef enterprise. In the study, a total of 20 male 9-10 month-old cattle, including 10 Simmental cattle and 10 Holstein cattle were used. The animals were equally divided into two groups. While the animals in the first group consumed current drinking water at the enterprise, those in the second group consumed drinking water enriched with oxygen. While the live weights of Holstein and Simmental cattle were 571.60 kg and 615.00 kg, respectively at the end of the semi-annual fattening period, the differences between breeds were statistically significant (P<0.05) for all periods, except for the first month. Daily live weight gains of Holstein cattle were detected as 633 g and 1133 g, respectively at the beginning (1st month) and the end (6th month) of the fattening period. The same values for Simmental breed were 933 g and 1233 g, respectively. The animals in the group consuming water enriched with oxygen had relatively higher values than the well water group for live weight change and daily live weight gains during the fattening periods. However, these differences were not statistically significant (P>0.05). In addition, the average feed conversion ratios during fattening were 7.18. and 7.26 respectively for the oxygen- enriched drinking water group and the well water group. It was determined that Simmental cattle (56.55%) had higher hot dressing percentage value than Holstein cattle (54.83%) and also those consuming water enriched with oxygen (56.02%) had higher dressing percentage value (55.36%) than those consuming well water. This was the first study on potential effects of drinking water with energized oxygen on fattening performance of cattle. Thereby, it is thought that the present study would provide a data archive for further studies.

Keywords: *Fattening Performance, Oxygen, Water.*

Enerjilendirilmiş Oksijen ile Muamele Edilmiş İçme Suyunun Besi Danalarında Performans Üzerine Etkisi

Abstract: Bu çalışma ticari bir besi işletmesinde sığırların içme sularının oksijence zenginleştirilerek hayvanların besi performansı ile karkas randımanları üzerine olası etkilerinin belirlenmesi amacıyla yapılmıştır. Çalışmada 9-10 aylık yaşlardaki 10' ar baş Simental ve Holştayn olmak üzere toplam 20 baş erkek dana kullanılmıştır. Hayvanlar eşit sayıda iki gruba ayrılarak, birinci grup, işletmede halihazırda bulunan içme suyundan; ikinci gruptaki hayvanlar ise oksijence zenginleştirilmiş içme suyundan tüketmiştir. Holştaynların 6 aylık besi sonundaki canlı ağırlığı 571,60 kg olurken; Simentallerin ise 615 kg olarak belirlenmiş, ilk ay hariç tüm dönemler için ırklar arasındaki farklar istatistiki açıdan önemli (P<0.05) bulunmuştur. Holştaynların besi başında (1. ay) ve besi sonundaki (6. ay) günlük canlı ağırlık artışı değerleri sırasıyla 633 g ile 1133 g olurken; aynı dönemlerdeki Simental ırkı için 933 g ile 1.233 g olarak belirlenmiştir. Çalışmada oksijence zenginleştirilmiş su içen gruptaki hayvanların besi süresince gerek canlı ağırlık değişimi gerek de günlük canlı artışı değerleri açısından kuyu suyu içen gruba göre nispeten daha yüksek değerlere ulaştığı görülmekle birlikte, söz konusu farklılıklar istatistiki önem teşkil etmemiştir (P>0.05). Yine oksijence zenginleştirilmiş içme suyunu tüketen grubun besi süresindeki ortalama yemden yararlanma oranı 7.18 olurken; aynı oran kuyu suyu tüketenler için ise 7.26 olmuştur. Çalışmada besi süresi sonrasında kesime sevk edilen Simentallerde (%56.55), Holştaynlara göre (%54.83), zenginleştirilmiş su tüketenlerde de (%56.02) kuyu suyu tüketenlere göre (%55.36) daha yüksek sıcak karkas randımanı değerleri belirlenmiştir. Çalışma, enerjilendirilmiş oksijenli içme suyunun sığırlarda besi performansı üzerine olası etkilerinin belirlenmesine yönelik ilk olma özelliğini taşımakta ve sonraki araştırmalar için de önemli bir veri niteliğinde olacağı düşünülmektedir.

Anahtar Kelimeler: *Besi Performansı, Oksijen, Su.*

Introduction

Besides the production amount of animal products, consumption amount is also taken into consideration as an important criterion in comparing development levels of countries (Sariozkan et al., 2007). Considering the shortage in red meat production against the rapid population growth, it is required to increase both yield and consumption of animal products by utilizing them optimally (Akdag, 2004).

Despite rapidly growing world population, especially the decreased number of the slaughter animals reared healthfully in Turkey has led to the deficiency of animal protein. Even though the rates of the culture animals and crossbred animals in the cattle population have increased in almost all the regions of Turkey primarily in the Marmara and Aegean regions, this is not enough to meet the red meat demand (Akman et al., 2005).

In this respect, the quality in fattening enterprises should be enhanced in quality and quantity. Fattening is called as the process of applying a special feed to animals in order to produce meat in the quality and quantity demanded by consumers (Akbulut and Tuzemen, 1994) and it is a crucial activity in terms of increasing meat amount obtained from slaughtered animals, enhancing their quality, and utilizing various animal feeds and industrial residues better (Catıkkas, 2015). In addition, fattening is a part of business that contributes to income for breeders. There are lots of factors such as age, management, type of diet, pre- and post-slaughter conditions affecting beef quality, carcass traits and profitability of the fattening of cattle. Breed is one of the most important factors. The live weight gains and feed consumption are not identical for different cattle breeds (Mundan et al., 2012; Guerrero et al., 2013). Holstein is a widely reared breed for milk production in the world and also about 78% of the European breeds in Turkey are Holstein. The males of this breed are mainly used for beef production, as well. Moreover, Simmental is one of the other European breeds raised in Turkey (Catıkkas and Koc, 2017)

Besides the quality of feed, it is important for animals to consume continuously clean and quality water in order to increase profitability in fattening enterprises. The quality of water used for cattle may be generally described by physical properties such as turbidity, color, and temperature as well as chemical properties such as hardness, alkalinity, pH, nitrate, nitrite, and metals and microbiological properties such as bacteria and virus (Unlu et al., 2008).

"Energized oxygen (EO)" is a gas that is generated from the stratosphere through sunrays and takes all its strength and efficiency from oxygen through Profoks generators. This technology derives the oxygen from the air (Protais et al., 2003; Yapıcıer and Saatcı, 2018). Some studies have revealed that animals such as chickens and turkeys grow heavier for a given grain consumption if their drinking water has elevated oxygen levels (Hough and Carlson, 1998). It is observed that the scientific interest has not been shown sufficiently on the yield of animals even though water is important in terms of their life functions. The aim of the study was to investigate the effect of the drinking water treated with energized oxygen on the fattening performance in order to enhance the quality of water consumed by animals.

Material and Methods

Animals and Data Collection: The study was conducted using a total of 20 male cattle aged 9-10 months including 10 Simmental and 10 Holstein cattle in a commercial fattening enterprise, operating in Isparta province, between 2017-2018. The animals were equally separated into two groups (5 Holstein and 5 Simmental in each) with 13 m^2 paddock surface per animal. While the current drinking water of the enterprise (well water) was used in the first group, the animals in the second group drank the drinking water saturated by high energy oxygen generator (profoks) installed as a separate main line by a private company in the well water system of the enterprise. The generator used in the study operates on a 24-hour basis. The amount of water consumed by each group was not detected.

The male animals in both groups (those consuming well water and enriched water) were fattened for 6 months. During the fattening process, the animals were fed with commercial feed concentrate containing 14.00% CP and 2600 kcal/kg ME along with hay and barley and consumed water *ad libitum*. They were weighed on a monthly basis and their yield records such as the live weight changes, daily live weight gains and feed conversion ratio were kept during certain periods of fattening and throughout the fattening period. At the end of the fattening period, all the animals were slaughtered and their hot carcass weights and dressing percentages were determined.

Approval from the Burdur Mehmet Akif Ersoy University Local Ethics Committee on Animal

Experiments (06.12.2017, resolution number: 351) were obtained for the study.

Statistical Analyses: All statistical analyses were carried out using Minitab 16.1 statistical software (2011). The effects of breed and drinking water on fattening performance and dressing percentages were analyzed by using ANOVA GLM procedure based on initial age and liveweights as a linear covariate. Additionally, Tukey's analysis was employed in controlling significance of differences between sub-groups (P<0.05). When the dual interactions between the groups were examined, the interaction analyses were not performed since no statistical significance was found.

Table 2 shows the effects of breed and drinking water status on the live weights at different periods of fattening. The live weights of Holstein and Simmental at the first, third, and last month were detected as 426.30 kg and 427.20 kg, 479.50 kg and 503.70 kg; 571.60 kg and 615.00 kg, respectively, and these values were statistically significant (P<0.05), except for the first month.

Results

Table 1 shows the values of the animals at the beginning of fattening period. According to this table, initial age and live weights were detected as 298.00 day and 407.20 kg for Holstein cattle and 286.20 day and 399.10 kg for Simmental cattle, respectively. The initial live weight of the animals consuming water enriched with oxygen was relatively lower (395.70 kg) than the other group (411.60 kg). The animals consuming water enriched with oxygen had higher values than the other group in terms of change of live weights during the fattening periods. However, these differences were not statistically significant (P>0.05).

Daily live weight gains of animals in the oxygen-enriched drinking water group were detected as 1066 g and 1333 g, respectively at the beginning (1st month) and the end (6th month) of the fattening period. These values of the other group (well water) were also 833 g and 1266 g, respectively (Table 3). Daily live weight gains were detected as 633 g and 1133 g for Holstein cattle and 933 g and 1233 g for Simmental cattle, respectively for the abovementioned periods.

Table 4 shows the feed conversion values of the groups. According the table, relatively high values were detected, the average feed conversion ratio of the oxygen- enriched drinking water group was 7.18. The ratio was detected as 7.26 for the other group. In addition, the differences between the groups were not statistically significant (P>0.05). Table 5 shows the effects of breed and drinking water on hot carcass and dressing percentages. As seen in this table, it was determined that Simmental cattle had higher hot dressing percentage value (56.55%) than Holstein cattle (54.83%) and this was statistically significant (P<0.05). While the oxygen-enriched drinking water group had higher value (56.02%) than the well water group (55.36%) in terms of dressing percentages, there was no significant difference between the groups (P>0.05).

Table 1. Values of cattle at the beginning of fattening.

Traits	Holstein	Simmental
Initial age (day)	298.00±8.90	286.20±7.75
Initial live weight (kg)	407.20±8.30	399.10±8.13
	Consumed water enriched with oxygen	**Consumed well water**
Initial age (day)	286.60±7,56	297.60±8.12
Initial live weight (kg)	395.70±7,50	411.60±7.69

Discussion and Conclusions

In the literature review, no study investigating the effect of the drinking water treated with energized oxygen on the fattening performance was found. Therefore, this study is important as it is the first study from this aspect.

When both breeds and both groups were assessed within the scope of the study, it was observed that the age at which the animals started fattening varied between 286-298 days. Likewise, some researchers (Akbulut and Tuzemen, 1994; Akcan et al., 1991; Ozdogan, 2007) have reported that the age to start fattening is 8-10 months in Holstein and Simmental cattle.

In the study, the live weights at the beginning and end (6th month) of the fattening were determined to be 407.20 kg and 571.60 kg for Holstein male cattle and 399.10 kg and 615.00 kg for Simmental male cattle, respectively and the total live weight gain for 6-month fattening period was 164.4 kg and 215.9 kg, respectively for those breeds. These live weight gains determined for Holstein cattle in the present study were found to be higher than the values reported by Tuzemen et al. (1990) and Gunes et al. (2001) and lower than the values reported by Basaran and Akcan (1997) and Erkus et al. (1990). The live weight gains found in this study were also lower than the values reported by Altuntas and Arpacık (2004) for CAA Simmental cattle and by Catıkkas (2015) and Aslan (2009) for Holstein and Simmental cattle. This was considered to be associated with the fact that the animals were more or less affected by environmental effects during fattening.

Table 2. Least squares for the effects of breed and drinking water status on live weight changes of the cattle during fattening periods (kg) ($\overline{x}\pm S_{\overline{x}}$).

Trait	FATTENING PERIOD					
	1st month	2nd month	3rd month	4th month	5th month	6th month
Breed						
Holstein	426.30±2.54	447.70±2.15	479.50±3.47	510.10±3.96	537.40±3.25	571.60±2.57
Simmental	427.20±2.48	464.50±3.33	503.70±4.01	540.70±4.17	578.30±4.07	615.00±3.33
P	0.832^{ns}	0.041*	0.016*	0.025*	0.009**	0.015*
Drinking water status						
Consumed water enriched with oxygen	427.10±2.35	460.90±4.75	502.70±3.47	533.80±3.77	563.00±4.21	603.80±2.05
Consumed well water	426.20±3.15	451.30±9.75	485.30±4.03	519.00±2.90	553.01±3.74	583.30±3.29
P	0.809^{ns}	0.243^{ns}	0.100^{ns}	0.207^{ns}	0.481^{ns}	0.248^{ns}

^{ns}: non-significant (P>0.05). *: P<0.05, **: P<0.01

Table 3. Least squares for the effects of breed and drinking water status on daily live weight gains of the cattle during fattening periods (kg) ($\overline{x}\pm S_{\overline{x}}$).

Trait	FATTENING PERIOD					
	1st month	2nd month	3rd month	4th month	5th month	6th month
Breed						
Holstein	0.633±0.044	0.700±0.043	1.066±0.069	1.033±0.042	0.900±0.073	1.133±0.070
Simmental	0.933±0.083	1.233±0.76	1.300±0.022	1.235±0.061	1.266±0.061	1.233±0.061
P	0.832^{ns}	0.020*	0.045*	0.633^{ns}	0.013*	0.043*
Drinking water status						
Consumed water enriched with oxygen	1.066±0.046	1.100±0.027	1.266±0.047	1.033±0.044	1.000±0.072	1.333±0.048
Consumed well water	0.833±0.076	0.835±0.073	1.133±0.072	1.130±0.067	0.966±0.046	1.266±0.079
P	0.819^{ns}	0.202^{ns}	0.188^{ns}	0.361^{ns}	0.131^{ns}	0.196^{ns}

ns: non-significant (P>0.05). *: P<0.05

Table 4. Feed conversion ratio of groups in fattening periods ($\overline{x}\pm S_{\overline{x}}$).

Fattening period	Consumed water enriched with oxygen	Consumed well water	P
1st month	5.42±0.127	5.44±0.108	0.556^{ns}
2nd month	5.31±0.224	5.39±0.207	0.613^{ns}
3rd month	6.52±0.186	6.63±0.343	0.596^{ns}
4th month	7.53±0.176	7.61±0.179	0.483^{ns}
5th month	9.08±0.331	9.19±0.404	0.545^{ns}
6th month	9.23±0.406	9.33±0.226	0.301^{ns}
Overall	7.18±0.247	7.26±0.314	0.642^{ns}

^{ns}: non-significant (P>0.05)

Table 5. Least squares for the effects of breed and drinking water status on hot carcass weight and dressing percentage ($\overline{x}\pm S_{\overline{x}}$).

Traits	Hot carcass weight (kg)	Dressing percentage (%)
Breed		
Holstein	317.61±6.67	54.83±1.06
Simmental	343.69±5.73	56.55±1.24
P	0.015*	0.001**
Drinking water status		
Consumed water enriched with oxygen	337.61±5.45	56.02±0.89
Consumed well water	323.69±6.01	55.36±0.95
P	0.165^{ns}	0.128^{ns}

^{ns}: non-significant (P>0.05). *: P<0.05, **: P<0.01

In the study, it was observed that the oxygen-enriched drinking water group had relatively higher live weight gain during the fattening compared to the group consuming well water and daily live weight gains were in favor of the oxygen-enriched drinking water group (P>0.05).

Likewise, in a study (Akbulut and Tuzemen, 1994) in which Holstein and Simmental cattle were fattened together, lower daily live weight gains were reported than the values reported in this study for Simmental cattle. On the other hand, Karakas (2002), Dannenberger et al., (2006) and Catıkkas (2015) reported relatively higher (1340 g and 1350 g) daily live weight gains than those determined in the present study. In this study, daily live weight gain differences between Simmental and Holstein breeds were found to be statistically significant in general (P<0.05). Some studies indicating similarity with the breeds in this study (Karakas, 2002; Dannenberger et al., 2006; Ozdogan, 2007) have revealed that the effect of breed is statistically significant. There are also studies reporting that the effect of breed on daily live weight gain is not statistically significant (Akbulut and Tuzemen, 1994; Aslan, 2009; Catıkkas, 2015).

In the study, group feeding was performed for both fattening groups (those that drank oxygen-enriched water and well water) due to the difficulties in determining the individual feed consumption of animals, and their feed conversion ratio (FCR) during fattening was determined. FCRs in the first, third, and sixth months were 5.42, 6.52 and 9.23, respectively, for the oxygen-enriched drinking water group and 5.44, 6.63 and 9.33, respectively, for the well water group. Concerning the FCRs (7.18 and 7.26) calculated in the six-month fattening period, it was determined that the oxygen- enriched drinking water group had a better performance in terms of FCR than the other group but this was not statistically significant (P>0.05). This may be associated with the fact that enhancing the quality of drinking water may cause an increase in the fattening performance of animals. Some studies in which the sulfate level was increased and the quality of the drinking water was impaired (Lonerakan et al., 2001; Zinn et al., 1997) reported that fattening performance values of cattle decreased, which supports this result. In addition, some researchers reported the positive effect of using energized oxygen treatment as a disinfectant for poultry sector (Yapıcıer and Saatcı, 2018; Sarı et al., 2018).

The FCRs determined in the study were found to be higher than the values reported by Akbulut and Tuzemen (1994) for Brown Swiss, Holstein and Simmental breeds (6.39, 6.74 and 6.27), those reported by Ozdoğan (2007) for Holstein and Brown breeds (6.85 and 6.40), and those reported by Yanar et al., (1990) for Brown Swiss (6.78 and 6.91). Also, the FCRs found in the present study were lower than the FCRs reported by different researchers (Altuntas and Arpacık, 2004; Baspınar et al., 1999; Gunes et al., 2001; Karakas, 2002) for Holstein and Simmental breeds.

All the animals completing fattening periods were slaughtered. It was determined that the hot carcass weight and dressing percentages of Simmental cattle (343.69 kg and 56.55%) were higher than the hot carcass weight and dressing percentages of Holstein cattle (317.61 kg and 54.33%) and the oxygen- enriched drinking water group had higher values than the other group and the difference between the breeds was statistically significant (P<0.05) and the difference between the groups was not statistically significant (P>0.05). The fact that the carcass values were observed in favor of Simmental cattle was thought to be caused by breed characteristics. On the other hand, the fact that the values were observed in favor of the oxygen-enriched drinking water group was thought to be associated with the positive effect of the water quality.

The dressing percentages are one of the important factors determining carcass quality. The dressing percentages determined in the present were compatible with a study (Akbulut and Tuzemen, 1994), examining the dressing percentages of the Holstein and Simmental cattle fattened at the age of 8-12 months. On the other hand, the values reported by Danneberger et al. (2006) have similarities in terms of Simmental cattle. Also, a study in which Holstein and Simmental cattle were fattened and slaughtered (Aslan, 2009), reported that yield values were quite higher; whereas, Catıkkas (2015) reported relatively lower hot carcass yield values than the values determined in the present study.

Fattening material output from Holstein cattle, the mostly reared culture breed in Turkey, for certain periods may be evaluated as a model that may be a solution for red meat deficit. Also, it is important to utilize the breeds with high fattening performance, slaughter and carcass characteristics in order to meet the increasing demand in Turkey and Simmental cattle, being one of these breeds, included in the study, is considered valuable for the sector.

Several researchers have conducted the studies on the fattening performance and slaughter properties of the breeds, which were used in this study and the importance of which was stated above, under different conditions.

It is seen that the scientific interest has not been shown sufficiently on the yield of animals even though drinking water is important in terms of their life functions. However, the experimental design for enhancing the quality of water consumed by the animals in a commercial fattening enterprise by a device producing energized oxygen and revealing comparatively the fattening performance and slaughter properties of beef cattle in the experimental group and control group is crucial as being the first in its field. Also, the results indicating that the oxygen-enriched drinking water group had relatively higher values of both fattening performance and slaughter characteristics than well water group even though these values were not statistically significant are thought to be important in terms of providing opportunity for developing further projects.

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References

Akbulut O, Tuzemen N, 1994: Fattening performance and carcass characteristics of Brown Swiss, Holstein and Simmental young bulls subjected to fattening at 8. and 12. month age. *Atatürk Ü Zir Fak Derg,* 25(2),134-144.

Akcan A, Arpacık R, Generen G, Karagenc L, 1991: The effect of starting time on fattening performance in Holstein bulls. *Lalahan Zoot Araşt Enst Derg,* 31(3-4), 9-16.

Akdag F, 2004: The effect of slaughter age on slaughter and carcass characteristics in indigenous water buffaloes*. J Fac Vet Med İstanbul Univ,* 30(2), 79-86.

Akman N, Tuncel E, Yener M, Kumlu S, Ozkutuk K, Tuzemen N, Yanar M, Koc A, Sahin O, Kaya CY, 2005: Türkiye'de sığır yetiştiriciliği. In: Türkiye Ziraat Mühendisliği VI. Teknik Kongresi, Ankara.

Altuntas M, Arpacık R, 2004: Fattenning performance and optimum slaughter weights of Simmental bulls in different starting ages*. Lalahan Hay Araşt Enst Derg,* 44(1), 7-16.

Aslan E, 2009: Comparison of the fattening performance of Holstein Friesian, Brown Swiss and Simmental breed cattle in feedlot at Middle Anatolian condition*.* Master Thesis, Selcuk University The Graduate School of Natural and Applied Sciences, Konya.

Baspınar H, Ogan M, Balcı F, 1999: Fattening performance and carcass characteristics of polish holstein bulls. *Lalahan Hay Araş Enst Derg*, 39(2), 1-6.

Basaran A, Akcan A, 1997: The effects of season on fattening performance, slaughter and carcass characteristics and feeding cost of Holstein bulls. *Lalahan Hay Araşt Enst Derg,* 37, 20-36.

Catıkkas E, 2015: A study on carcass and beef quality characteristics of Holstein-Friesian, Brown-Swiss and Simmental bulls fattened in Aydın province*.* Master Thesis, Adnan Menderes University, The Graduate School of Natural and Applied Sciences, Aydın.

Catıkkas E, Koc A, 2017: Fattening performance, carcass characteristics and beef quality of Holstein–Friesian, Brown–Swiss and Simmental bulls. *ADÜ Ziraat Derg*, 14(1), 59-64.

Dannenberger D, Nuernberg K, Nuernberg G, Ender K, 2006: Carcass-and meat quality of pasture vs concentrate fed German Simmental and German Holstein bulls. *Arch Anim Breed*, 49(4), 315-328.

Erkus A, Ozcelik A, Gurdogan T, Turan A, 1990: Siyah Alaca sığırlarının besisinde optimal besi süresinin tespiti. *Çiftçi ve Köy Dünyası Dergisi,* 6, 18-27.

Guerrero A, Valero MV, Campo MM, Sanudo C, 2013: Some factors that affect ruminant meat quality: from the farm to the fork. Review. *Acta Scientiarum*, 35, 335-347.

Gunes H, Kaygısız F, Kocak O, Pekgoz M, Gor M, 2001: Studies on the fattening performances of Holstein Friessian male cattle and economic analysis of fattening*. J Fac Vet Med İstanbul Univ,* 27(1), 243-253.

Hough GS, Carlson DV, 1998: Method and Apparatus For Generating Oxygenated Water. https://patentimages.storage.googleapis.com/ae/63/fc/79aa72b4171716/US5728287.pdf Accessed; 14.11.2019.

Karakas E, 2002: The birth weight weaning age, milk consumption and the survival rate of Holstein calves raised in dairy farms located in Bursa-Yenisehir district. *Uludag Univ J Fac Vet Med*, 21, 77-81.

Loneragan GH, Wagner JJ, Gould DH, Garry FB, Thoren MA, 2001: Effects of water sulfate concentration on performance, water intake, and carcass characteristics of feedlot steers*. J Anim Sci*, 79(12), 2941-2948.

Minitab, 2011: Minitab For Windows Version Release 16, Minitab Inc.

Mundan D, Gogebakan S, Ergun C, Kaban IH, 2012: Evalution of fattening performance of Holstein cattle at different initial weights under summer season conditions in the district of Silifke of Mersin province. *J Anim Vet Adv,*11(2), 186-190.

Ozdogan M, 2007: A research on some fattening performance parameters of Holstein Friesian and Brown Swiss young bulls under summer season conditions in Aydın province. *Hayvansal Üretim*, 48(2), 1-6.

Protais J, Queguiner S, Boscher E, Piquet JC, Nagard B, Salvat G, 2003: Effect of housing system on the bacterial flora in the air and on egg shells. In: Proceedings of the Tenth European Symposium on the Quality of Eggs and Egg Products, Ploufragan, France, pp. 142-149.

Sarı M, Yapıcıer OS, Usta Z, Saatcı M, 2018: Usage of energized oxygen gas as an alternative disinfection

product on hatching eggs. In: Proceedings of the First International GAP Agriculture, Livestock Congress, Şanlıurfa, Turkey, pp. 407-410.

Sariozkan S, Cevger Y, Demir P, Aral Y, 2007: The consumption situation and habits of livestock products among the students of Erciyes University Veterinary Faculty. *Sağlık Bilimleri Dergisi,* 16(3), 171-179.

Tuzemen N, Yanar M, Tellioglu S, Emsen A, 1990: Sarı-Alaca, Siyah-Alaca, Esmer ve Norveç Kırmızısı x Esmer melezi tosunların besi performansı ve karkas özellikleri üzerine karşılaştırmalı bir araştırma. *Doğa Türk Veterinerlik ve Hayvancılık Dergisi*, 14, 47-54.

Unlu A, Coban F, Tunc MS, 2008: Investigation of Lake Hazar water quality according to physical and inorganic chemical parameters. *J Fac Eng Arch Gazi Univ*, 23(1), 119-127.

Yanar M, Tuzemen N, Aksoy A, Vanlı Y, 1990: İki ayrı yaşta besiye alınan Esmer tosunlarda besi performansı, optimum besi süresi ve karkas özelliklerinin saptanması üzerine bir araştırma. *Türk Veterinerlik ve Hayvancılık Dergisi*, 14, 239-246.

Yapıcıer OS, Saatcı M, 2018: Energized oxygen treatment in drinking water for laying hens: an alternative disinfectant. *Int J Poult Sci*, 17(12), 586-590.

Zinn RA, Alvarez M, Mendez, Montano M, Ramirez E, Shen Y, 1997: Influence of dietary sulfur level on growth performance and digestive function in feedlot cattle. *J Anim Sci,* 75, 1723-1728.

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