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RESEARCH ARTICLE

Effect of Crating Position During Transport on Welfare and Oxidative Stress in Laying Hens

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ABSTRACT

This study was carried out to investigate the effects of crating position of laying hens during transport on live weight loss, mortality rate, plasma biochemical, and oxidative stress parameters under commercial transport conditions in Afyonkarahisar. A commercial multi-decked and fixed-crate-type poultry transport trailer was used for bird transportation. The hens were transported in 9 selected loading positions on the trailer's front, center, rear sections, and top, middle, and bottom rows. Both pre-transport and post-transport hens were weighed individually, and blood samples were taken. Live weight loss, mortality rate, glucose, MDA, AOA, and cortisol concentrations increased, triglyceride and cholesterol concentrations decreased in the hens transported between farm and slaughterhouse. The hens loaded in the bottom row and rear section were most adversely affected by transportation and, the welfare loss of these hens was dramatic. It has been observed that the microclimate conditions of the transport crates in the bottom row are more unfavorable than those in the other positions. The results showed that transport crates positioned in the bottom row and rear section of the trailer were more stressful for laying hens. In conclusion, the potential stress profile of the position of the animal crates during transport can contribute to the strategic solutions to be developed to reduce the welfare losses of laying hens.

Key Words: Crate position, Laying hens, Oxidative Stress, Transport, Welfare

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Yumurtacı Tavuklarda Nakil Kasası Pozisyonunun Hayvan Refahı ve Oksidatif Stres Üzerine Etkisi

ÖZ

Bu araştırma Afyonkarahisar'da ticari nakil koşullarında yumurtacı tavukların nakil aracındaki taşınma pozisyonunun canlı ağırlık kaybı, ölüm oranı, serum biyokimyasal ve oksidatif stres parametreleri üzerine etkisini araştırmak için yapılmıştır. Tavukların taşınması için ticari birçok katlı ve sabit hayvan kasalı kanatlı hayvan nakil kamyonu kullanılmıştır. Tavuklar, kamyon dorsesinin ön, orta ve arka bölümleri ile üst, orta ve alt katlarında belirlenen 9 yükleme pozisyonunda taşınmıştır. Hem nakil öncesi hem de nakil sonrası tavuklar bireysel olarak tartılmış ve kan örnekleri alınmıştır. Çiftlik ile kesimhane arasında taşınan yumurtacı tavuklarda canlı ağırlık kaybı, ölüm oranı ile glikoz, MDA, AOA ve kortizol konsantrasyonları artmış, trigliserit ve kolesterol konsantrasyonları azalmıştır. Nakilden en fazla alt katta ve arka bölümde taşınan tavuklar etkilenmiş ve bu tavukların refah kaybı dramatik olmuştur. Alt katta bulunan nakil kasalarının mikro iklim koşullarının diğer pozisyonlardaki nakil kasalarına göre daha olumsuz olduğu gözlemlenmiştir. Sonuçlar kamyonun alt katında ve arka bölümünde bulunan nakil kasalarının yumurtacı tavuklar için daha stresli olduğunu göstermiştir. Nakil kasası pozisyonuna ait potansiyel stres profilinin yumurtacı tavukların refah kayıplarını azaltmak için geliştirilecek stratejik çözümlere katkı sağlayabileceği sonucuna varılmıştır.

Anahtar Kelimler: Kasa pozisyonu, Nakil, Oksidatif stres, Refah, Yumurtacı tavuk

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INTRODUCTION

Studies to increase animal welfare have accelerated in the last few decades, especially in industrialized and developing countries. As in the EU, awareness, and demands of consumers, citizens, and non-governmental organizations on animal welfare are increasing rapidly in Turkey (Moura et al. 2006, Makdisi and Marggraf 2011, Rezai et al. 2012). So, Council Regulation (EC) No 1/2005 for protecting animals during transport has been transposed into national legislation in Turkey (Passantino 2006, Bozkurt 2018).

The complex production cycle of an intensive animal production system focused on increasing economic efficiency makes processing poultry more stressful and challenging. Transporting animals is also a stressful and traumatic process (Kettlewell and Mitchell 1994). Poor transport conditions such as rough capture, carrying and handling and, restraint (Voslarova et al. 2007), high loading density (Waas et al. 1997), long transport (Ondrašovičová et al. 2008), and unfavorable microclimatic circumstances (Vecerek et al. 2016) enhance welfare losses during the transport of poultry.

Rough handling of animals and environmental stressors causes physiological and biochemical deviations and causes an increase in anxiety and fear, and decreases welfare in animals (Minka and Ayo 2009, Piccione et al. 2013). Poor transportation conditions reduce poultry meat quality, as scientifically verified (Nijdam et al. 2005). Unfriendly animal handling and adverse transport conditions can cause muscle trauma, fractures, and ultimately death in chickens (Wolff et al. 2019). Regulations, recommendations, and guidelines have been entered into force to protect animals during transport, prevent economic losses resulting from welfare losses, and improve food quality in the EU. However, studies report severe welfare losses when transporting food animals by road (Minka and Ayo 2009). Welfare problems related to transportation are more mentioned for spent hens than broiler chickens and other poultry species. These statements bring to mind the extent to which the legal and administrative sanctions aimed at protecting chickens during transport realize their purpose in commercial conditions.

Although detrimental effects of transportation on animals have been well explained, the responses of different animal species to stressors or detailed results regarding their capacity to cope with stress have still not been confirmed (Kettlewell and Mitchell 1994, Onmaz et al. 2011, Vecerkova et al. 2019). Studies reported different tenderness and mortality rates against transport stress for poultry species (Machovcova et al. 2017, Al-obaidy et al., 2020). Researches have been realized to prevent or reduce harmful effects ranging from distress to transport death in animals. Still, consistent, reliable, and applicable solutions in commercial conditions have not been reached yet (Ondrašovičová et al., 2008).

Transportation is very stressful for laying hens when they are delivered to slaughterhouses or processing plants. Careless handling, long-distance transport in fixed crates (Kettlewell and Mitchell 1994, Weeks et al. 2012, Vecerkova et al. 2019), the low number of processing plants that accepting laying hens that reached end-of-lay period due to their low economic value, and insufficient financial support to improve animal well-being (Petracci et al. 2006, Lara and Rostagno 2013) are cause poor welfare in chickens.

Regulations monitoring animal welfare are being implemented, but new scientific studies are needed to support the regulations' standards or to develop these standards. However, it has been reported that research on the welfare of end-of-lay hens during transport is also limited (Bozkurt 2018). More research is needed to develop appropriate strategies to control of environmental conditions to increase knowledge about the negative aspects of transport to laying hens to prevent transport-induced stress and damage, and to improve the welfare of laying hens during transport (Al-obaidy et al. 2020, Machovcova et al. 2017, Vecerkova et al. 2019).

This study was carried out to examine the effects of crating position of hens during transport on live weight loss, mortality rate, plasma biochemical, and oxidative stress parameters in laying hens under commercial transport conditions in Afyonkarahisar.

MATERIALS AND METHODS

Materials and Experimental Design

The study was held under commercial poultry transport conditions in Afyonkarahisar, which has approximately 20% of the laying hen population in Turkey. A total of 2304 white laying hens (64-weeks-old) were used. The hens were transported by a commercial poultry transport trailer with a 12-decked, fixed crated, and open-sided (without a protective cover).

The animal-based assessment was carried out only for the hens that were crated on nine positions in the truck's trailer (the crates located on rows 1, 6, and 12 from bottom to top in each of the truck trailer's front, center, and rear sections). After unloading the flock, dead hens were counted in 18 crates on the same positions and symmetrically located on both sides of the trailer. The width, length, and height were 95 cm, 95cm, and 19 cm respectively of fixed crates with flat sheet floor. An electronic digital scale with a precision of 10 g was used when weighing the birds.

Implementation and Transport

The laying hens housed in multi-tiered aviary system were starved for 6 hours before transport. After removing from the multi-tier cages, the hens were individually numbered, weighed, and taken blood samples. The hens were carried and loaded into the trailer by hand up to 5-6. Loading density was applied as 12 hens per crate to comply with the relevant legislative requirements (Regulation on welfare and protection of animals in transportation, 24 December 2011, number: 28152) and avoid the effects of high loading stress. The loading of hens started at 14.00 and finished at 17.45 in the same afternoon. The average truck speed was 50 km/h during the journey. The journey lasted an hour on 40 km between the farm and the slaughterhouse. The hens have been waited in the crates for a further 3 hours after arrival at the slaughterhouse because of the workload in the slaughterhouse. No feed or water has been given to the birds during this lairage time onto the trailer. After unloading, hens were weighed, and blood samples were taken with the same procedure applied before the transport. After unloading, the dead birds were counted in the crates and the mortality rate was calculated as the percentage of birds dead on arrival (DOA).

The research was carried out in the winter season (January 2020). Air temperature values have hourly measured during the whole transport process in the day, and the max and min. air temperature values were 8 and 3°C. Excluding the process of blood sampling, numbering, and weighing, all animal transport processes such as catching, carrying by hand, loading, and unloading the hens were performed professionally by employees of the commercial poultry transport company operating in the province.

Blood Sampling and Biochemical Analyzes

The blood samples were drawn from the wing vein before and after transport. Vacuum tubes without anticoagulants were used for blood samples. Blood samples were centrifuged at 3000 rpm for 15 minutes. Subsequently, the plasma samples were collected and stored in a - 80°C freezer until laboratory analysis. Plasma glucose, triglyceride, and cholesterol levels were measured on a Siemens Centaur CP analyzer by Siemens assay kits (Siemens Centaur CP kits). The chemiluminescent microparticle immunoassay (CMIA) method of plasma cortisol analysis was conducted on Abbott Architect Diagnostics I2000 analyzer using the Architect/Abbott kits. The concentrations of Malondialdehyde (MDA) and Antioxidant capacity (AOA) in plasma were determined using poultry Elisa kits (BT-lab ELISA kits) (Draper and Hardley 1990, Koracevic et al. 2001). The ELISA measurements were performed using the BioTek EX 800 Absorbance Microplate Reader. Afyon Kocatepe University Animal Research Ethics Committee approved this research with the reference number AHUHADYEK-154-20.

Statical Analysis

One-way analysis of variance (One-way ANOVA) was used to evaluate the differences between the crating position groups in terms of cortisol, glucose, triglyceride, cholesterol, MDA, and AOA in the plasma and live weight and weight loss. A paired t-test (paired-sample T-test) was applied to compare the plasma values taken before and after transportation for live weight, cortisol, glucose, triglyceride, cholesterol, and oxidative stress parameters in each loading position. The non-parametric test (kruskal-wallis test) was adopted to compare the crating position groups for mortality rates (DOA percentage) during transport. SPSS 21.0 (IBM Company, USA) was used for the analyses.

RESULTS

The results on the live weight, weight loss, and mortality rate in crate position groups are shown in Table 1. The effect of the position of the transport crates on the trailer on the pre-transport live weight was insignificant. Although the impact of crate row on the trailer on live weight after transport was negligible, the post-transport live weight averages were significantly different for crate sections ($p<0.05$). The transport position of the hens had a significant effect on transport-induced weight loss. Weight loss was similar in hens positioned on different trailer rows but differed significantly in weight loss between hens transported on the front, center, and rear sections ($p<0.001$). The mortality rate was not statistically affected by the crating position on the trailer.

The results related concentrations of plasma cholesterol, triglyceride, and glucose before and after transport are presented in Table 2. Significant differences were determined between the plasma cholesterol and triglyceride values determined before and after transportation ($p<0.05$, $p<0.001$). In general, cholesterol and triglyceride mean values were 143.10 mg/dl and 1160.67 mg/dl before transport, and those values were 99.08 mg/dl and 612.10 mg/dl after transport, respectively. Transport increased the concentration of plasma glucose levels in all position groups, but these increases were significant only for hens transported in the middle row and rear section.

Means of plasma cholesterol and triglyceride before transport did not differ significantly between transport position groups.

Though the concentration of plasma cholesterol after transportation in different trailer sections was similar, transport of the birds in the middle and top rows affected plasma cholesterol levels ($p<0.001$). Plasma triglyceride concentration was not affected by crate row. Still, it was higher in chickens transported in the center section of the trailer than in chickens transported in the front and rear sections ($p<0.001$).

The results of cortisol, malondialdehyde, and antioxidant capacity regarding the crate's position are given in Table 3. There was a significant increase in plasma cortisol levels due to transportation in all position groups ($p<0.001$, $p<0.01$).

Table 1. The results of live weight, weight loss, and mortality rate regarding the crate's position on the trailer during transport

Crate position		Live weight (kg)					Weight loss (%)		Mortality rate (%)			
		Before transport		After transport		t						
		n	$\bar{X} \pm Sx$	n	$\bar{X} \pm Sx$	P	n	$\bar{X} \pm Sx$	n	$\bar{X} \pm Sx$	chi-square	P
Row	Top	36	1.87 ± 0.03	36	1.66 ± 0.04	***	36	11.75 ± 0.61	3	2.50		
	Middle	36	1.82 ± 0.04	33	1.65 ± 0.04	***	33	11.60 ± 0.79	3	5.33		
	Bottom	36	1.83 ± 0.03	31	1.61 ± 0.03	***	31	12.63 ± 0.92	3	7.17	5.054	NS
Section	Front	36	1.87 ± 0.03	34	1.70^{a} ± 0.03	***	34	9.73^{c} ±0.60	3	4.33		
	Center	36	1.81 ± 0.04	34	1.61^{ab} ± 0.04	***	34	11.84^{b} ±0.72	3	4.50	0.940	NS
	Rear	36	1.84 ± 0.04	32	1.59^{b} ± 0.04	***	32	14.51^{a} ±0.76	3	6.17		
ANOVA												
Row			NS		NS			NS				
Section			NS		*			***				

***p<0.001 *p<0.05 NS: Not significant

*p<0.05 ^{a,b,c} There are significant differences between groups with different letters(p<0.05)

Table 2. The results of cholesterol, triglyceride, and glucose regarding the crate's position on the trailer during transport

Crate position			n	Cholesterol (mg/dl) Before transport	Cholesterol (mg/dl) After transport	P	Triglyceride (mg/dl) Before transport	Triglyceride (mg/dl) After transport	P	Glucose (mg/dl) Before transport	Glucose (mg/dl) After transport	P
				$\bar{X}$ ± Sx	$\bar{X}$ ± Sx		$\bar{X}$ ± Sx	$\bar{X}$ ± Sx		$\bar{X}$ ± Sx	$\bar{X}$ ± Sx	
Row	Top		16	140.94 ± 8.22	81.25^{b} ± 2.93	***	1169.94 ± 106.34	674.17 ± 43.50	***	201.75 ± 2.62	206.13 ± 3.88	NS
	Middle		18	139.44 ± 11.69	122.06^{a} ± 10.87	NS	1168.33 ± 90.38	533.19 ± 41.04	***	198.94 ± 3.13	212.56 ± 3.51	**
	Bottom		18	148.67 ± 8.99	91.94 ^{ab} ± 3.42	***	1144.78 ± 117.54	635.83 ± 53.20	***	202.06 ± 2.66	203.83 ± 2.75	NS
Section		Front	17	142.24 ± 6.72	96.20 ± 4.46	***	1335.71 ± 103.55	552.08^{b} ± 38.82	***	199.29 ± 2.66	204.42 ± 3.71	NS
		Center	18	133.78 ± 9.77	96.56 ± 7.97	*	1030.28 ± 87.40	732.80^{a} ± 51.88	**	199.83 ± 2.92	205.44 ± 3.17	NS
		Rear	17	153.83 ± 11.92	104.62 ± 10.79	**	1123.71 ± 110.89	544.31^{b} ± 37.59	***	203.59 ± 2.84	212.94 ± 3.24	*
ANOVA												
Row				NS	***		NS	NS		NS	NS	
Section				NS	NS		NS	**		NS	NS	

***p<0.001 **p<0.01 *p<0.05 NS: Not significant
*p<0.05 ^{a,b}There are significant differences between groups with different letters(p<0.05)

Table 3. The results of cortisol, malondialdehyde, and antioxidant capacity regarding the crate's position on the trailer during transport

Crate position			n	Cortisol (ug/dL) Before transport	Cortisol (ug/dL) After transport	P	Malondialdehid (MDA) (nmol/ml) Before transport	Malondialdehid (MDA) (nmol/ml) After transport	P	Antioxidant capacity (AOA) (nmol/l) Before transport	Antioxidant capacity (AOA) (nmol/l) After transport	P
				$\bar{X}$ ± Sx	$\bar{X}$ ± Sx		$\bar{X}$ ± Sx	$\bar{X}$ ± Sx		$\bar{X}$ ± Sx	$\bar{X}$ ± Sx	
Row	Top		16	1.13 ± 0.03	1.33 ± 0.06	***	1.40^{b} ± 0.04	1.74 ± 0.06	***	7.01 ± 0.18	7.47 ± 0.18	*
	Middle		18	1.17 ± 0.02	1.41 ± 0.06	**	1.47^{ab} ± 0.05	1.64 ± 0.05	***	7.06 ± 0.18	7.52 ± 0.23	*
	Bottom		18	1.17 ± 0.03	1.34 ± 0.05	*	1.59^{a} ± 0.04	1.80 ± 0.05	***	7.36 ± 0.14	7.53 ± 0.15	NS
Section		Front	17	1.15 ± 0.02	1.50^{a} ± 0.19	*	1.45 ± 0.04	1.74 ± 0.06	***	6.91 ± 0.17	7.30 ± 0.19	*
		Center	18	1.18 ± 0.04	1.35 ^{b} ± 0.21	*	1.45 ± 0.03	1.68 ± 0.05	***	7.10 ± 0.13	7.54 ± 0.21	*
		Rear	17	1.15 ± 0.02	1.24 ^{b} ± 0.13	NS	1.57 ± 0.06	1.76 ± 0.04	**	7.45 ± 0.18	7.67 ± 0.13	NS
							*	-				
ANOVA												
Row				NS	NS		*	NS		NS	NS	
Section				NS	**		NS	NS		NS	NS	

***p<0.001 **p<0.01 *p<0.05 NS: Not significant
*p<0.05 ^{a,b}There are significant differences between groups with different letters(P<0.05)

As an oxidative stress parameter, MDA was also increased in transported hens ($p<0.001$, $p<0.01$). Similarly, transport of the birds resulted in an increase in AOA averages except for the hens transported on bottom rows and rear sections.

There was no significant difference between crate positions in terms of plasma cortisol concentration before transplantation. Post-transport plasma cortisol level was not affected by the crate row, but it was significantly affected by the crate section. The increase in cortisol concentration exchanged more pronounced as the position in which the hens were crated onto the trailer changed from rear to front.

Differences among the top, middle and bottom rows regarding plasma MDA means were significant ($p<0.05$) before transportation but were insignificant after transport. The highest and lowest MDA means were found in hens transported to the bottom and top rows, respectively. Neither before nor after transport AOA concentrations were not affected by crate row. The transport did not affect plasma MDA and AOA levels in hens transported in the crates positioned onto the trailer's front, center, and rear sections.

DISCUSSION

Pre-slaughtering transport of old laying hens resulted in body weight loss and deaths (DOA) in the study. These results were not surprising, as many researchers reported that transporting poultry is a stressful manufacturer's operation (Minka and Ayo 2009, Ajakaiye et al. 2010, Miranda-de la Lama et al. 2012). In line with the results of this study, Ondrašovičová et al. (2008) reported that factors related to animal transport such as catching, handling, and journey time significantly affect body weight loss during transport in broiler chickens.

The mortality rates determined in the study were between 2.50 and 7.17%. These rates indicated that the transport conditions in the study were unfavorable and stressful, and the old laying hens were quite sensitive to these conditions. These mortality rates are higher than the DAO percentages in Europe reported for broilers (0.31-1.64%)(Voslarova et al. 2007, Vecerek et al. 2016, Jacobs et al. 2017) or turkeys (0.15-0.38%)(Petracci et al. 2006, Machovcova et al. 2017). The mortality in this study was higher than the values (0.72 - 1.22 %) reported in the limited number of studies examining the transport stress in layer hens (Petracci et al. 2006, Vecerkova et al. 2019). These results were attributed to hand catching and moving hens to the trailer, rough animal handling during loading, and poor microclimatic conditions in animal crates during lairage before unloading (Nijdam et al. 2005, Voslarova et al. 2007, Langkabel et al. 2015). Also, considering that the research was conducted in the winter season, it was argued that cold stress may have been very effective in increasing chicken deaths. Because the protective cover was not used and the surrounding of the trailer was open during the journey. Moreover, the studies on the transport of broiler and spent hens in the winter season reported higher DOA percentages than those poultry transports has been done in other seasons (Vecerek et al. 2016, Vecerkova et al. 2019). In addition, the high mortality rate was also associated with the age of laying hens (64 weeks of age) that were used in this study as farm animal species. Because spent hens are very fragile, and rough and careless handling during catching, loading, transportation, lairage, and unloading may have played a role in the increase in DOA percentages due to internal organ, muscle or bone traumas. Benincasa et al. (2020) reported that microclimatic conditions in the animal transport crates during animal transporting and lairage processes caused stress and decreased bird welfare.

The blood profile also confirmed the stress status related to the transport position of the hens. So, there was a decrease in cholesterol concentration and an increase in cortisol and glucose concentrations in transported chickens. In a similar study, Nijdam et al. (2005) reported that corticosterone and glucose levels increased during the capture and transport of broiler chickens. In addition, the decrease in triglyceride concentration in this study is further evidence of the stress response of chickens to transport. Also, Al-obaidy et al. (2020) reported similar results to these findings. Remage-Healey and Romero (2001) said that plasma triglyceride levels decrease during stress as a dimension of lipid regulation in poultry. Again, the MDA and AOA levels determined in this study indicate the oxidative damage in the transported hens (Onmaz et al. 2011, Pamok et al., 2019). The crate row position slightly affected the bodyweight loss of transported hens, but the crate section strongly influenced bodyweight loss. Bodyweight loss was increased linearly as the position of the transport crates went away from front to rear on the trailer. Similar results were found for the mortality rate, but the differences among the crate position groups were statistically insignificant. Bodyweight loss and mortality increased slightly as the crate position replaced from top to bottom rows.

The obtained results in the study showed that the position of the chicken transport crate on the trailer affected animal welfare. The stress conditions of the transport crates located in different sections or rows on the trailer were also different. Nevertheless, the impact of the trailer section was more meaningful on transport stress than trailer rows. Moreover, weight loss and cortisol and triglyceride concentrations in transported hens exhibited significant differences among crate sections. It has been observed that the hens transported in the rear section of the trailer were adversely affected by transport than those transported in other sections. The low triglyceride concentration, slightly elevated glucose, and oxidative stress markers were emphasized to the higher stress in hens transported in the back of the trailer. The obtained results suggest that transporting hens in the rear section of the trailer may be more stressful, and animal welfare may decline, resulting in even death (Nielsen et al. 2011, dos Santos et al., 2017).

The reason for this may be that the rear section of the trailer may be more affected by the cold weather conditions, and the hens transported in this section may have been exposed to acute hypothermia. Because twelve hens were loaded in each crate to avoid high loading density according to legal sanctions, this may have caused the effect of cold stress to be greater than expected, especially in the rear section (Marahrens et al. 2011). So, It has already been reported that the climatic conditions of the immediate environment in which the animals are placed affect animal welfare (Benincasa et al. 2020). Dos Santos et al. (2017) reported that the temperature and humidity were higher in the trailer's rear section in animal transports during the warm season. Therefore, the transport stress was higher in the rear section. Also, the vibrations depending on the driving speed of the truck and the road's surface condition may have negatively affected the chickens transported in the rear of the trailer. Zhou et al. (2015) reported that transport vibration levels increased with truck speed, road conditions, load level, and overloading.

In general, the hens transported in the bottom row and rear section of the trailer were most adversely affected, and the welfare losses of these birds were higher. Waas et al. (1997) determined that deer transported in the rear and center sections of the trailer had higher heart rate and plasma lactate levels than those transported in the front section, in parallel with the results of this study. The researchers explained that the trailer's rear section might have been shaken more due to the truck's speed or the high transport vibration during the journey, and those loaded on the rear section may have had to do more physical activity to stay in balance. However, Vignola et al. (2008) and Dos Santos et al. (2017) reported that transport, season, or handling had a significant impact on animals transported than their position on the trailer.

It was determined that there was higher mortality and relatively slightly higher MDA and live weight loss in the bottom crate. These results show that the crates' microclimate on the bottom rows (insufficient oxygen, polluted air, high temperature, humidity, etc.) are adverse compared to the crates on the middle and top rows. It was thought that the fact that the side protection covers of the trailer bed were closed during the journey may have prevented the ventilation in the bottom rows to some extent. Also, Vecerkova et al. (2019) emphasized that old layer hens transported to the slaughterhouse may be more susceptible to transport stress and poor transport conditions than other poultry types. Also, Mitchell and Kettlewell (1994) reported that inadequate ventilation causes heterogeneous temperature and humidity in the transport vehicle and increases the risk of heat stress. Ajakaiye et al. (2010) said that high-temperature stress causes weight loss in chickens.

CONCLUSIONS

Consequently, Live weight loss, mortality rate, glucose, MDA, AOA, and cortisol levels were increased, while triglyceride and cholesterol levels decreased in laying hens transported between farm and slaughterhouse. The results showed that transport crates located in the bottom row and rear section of the trailer are very stressful and have a high risk for poor welfare for laying hens. The potential stress and risk profile of the animal crate's position on the trailer can instruct strategic solutions to reduce the welfare losses of the laying hens during transport.

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