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Determination and Evaluation of Noise Pollution in Layer Hen House: A Bursa Case Study

Yumurta Tavuğu Kümesinde Gürültü Kirlilik Düzeyinin Belirlenmesi ve Değerlendirilmesi: Bursa Örneği

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Abstract: Both animals and employees need to improve the indoor conditions in livestock barns and keep them at an optimum level. With the development of automation systems for increased productivity and mechanisation, more systematic production occurs within the poultry houses and the need for a workforce is reduced. However, the increase in industrialisation and herd size can cause noise pollution problems in the poultry house. In this study, noise levels were measured and statistically evaluated in a laying hen farm operating in a battery-type cage in the Bursa region. It is aimed to be assessed according to environmental pollution and animal welfare. It was measured in the corridors between the rows of cages and on the cage floors with the studied facility's noise meter (EXTECH SDL600). The obtained noise data were determined by the SPSS statistical program, the variance analysis of the differences between the corridors and the relationship between the layer hen house environmental factors (temperature, humidity and wind speed) and the regression analysis. According to the results measured throughout the year in the investigated enterprise, the maximum noise intensity was measured as 80.6 dB, and the minimum noise intensity was measured as 76.3 dB. The differences between the noise values measured in the aisles and floors of the cage rows are statistically significant.

Keywords: animal welfare, laying hen, noise

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Öz: Hayvan barınaklarında iç ortam koşullarının iyileştirilmesi ve optimum düzeyde tutulabilmesi hem hayvanlar açısından hem de çalışanlar için oldukça önemlidir. Verim artışına yönelik otomasyon sistemlerinin gelişmesi ve makineleşmenin artmasıyla kümesler içerisinde daha sistematik üretim gerçekleşmekte ve insan gücüne ihtiyaç azalmaktadır. Fakat makineleşmenin ve sürü büyüklüğünün genişlemesi kümes içerisinde gürültü kirliliği problemine neden olabilmektedir. Bu çalışmada, Bursa bölgesinde faaliyet gösteren batarya tipi kafeste yetiştiricilik yapılan yumurta tavuğu kümesinde gürültü düzeyleri ölçülmüş ve istatistiksel olarak değerlendirilmiştir. Çevre kirliliği ve hayvan refahına göre değerlendirilmesi amaçlanmıştır. İncelenen işletmede gürültü ölçer (EXTECH SDL600) ile kafes sıraları arasındaki koridorlarda ve kafes katlarında ölçülmüştür. Elde edilen gürültü verileri SPSS istatistik programıyla koridorlar arasındaki farklılıklar varyans analizi ve kümes içerisindeki çevresel faktörler (sıcaklık, nem ve rüzgâr hızı) ile arasındaki ilişki regresyon analiziyle belirlenmiştir. İncelenen işletmede yıl boyunca ölçülen sonuçlara göre maksimum gürültü şiddeti 80.6 dB, minimum gürültü şiddeti 76.3 dB olarak ölçülmüştür. Kafes sıraları koridorlarında ve katlarında ölçülen gürültü değerleri arasındaki farklılıklar istatistiksel açıdan önemlidir.

Anahtar Kelimeler: hayvan refahı, yumurta tavuğu, gürültü

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İntihal-Plagiarism/Ethic: Bu makale, en az iki hakem tarafından incelenmiş ve intihal içermediği, araştırma ve yayın etiğine uyulduğu teyit edilmiştir. / This article has been reviewed by at least two referees and it has been confirmed that it is plagiarism-free and complies with research and publication ethics. https://dergipark.org.tr/tr/pub/ijaws

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INTRODUCTION

Today, with the increase in food demand due to population growth, poultry production has become an even more important sector with its favourable aspects. Technological and automation systems have developed rapidly to increase productivity in the poultry sector. Modern enterprises have become widespread as Turkey quickly adapts to technological developments, automation and integrated systems in poultry farming. Appropriate living conditions should be provided for the animals to perform their vital activities in the poultry house (Durgun, 2021). Especially in livestock barns with intensive production, improvement of indoor conditions plays an important role for both animals and workers. Developments such as increased mechanization in livestock barns and the growth of herds trigger noise pollution.

In livestock barns, the ventilation system, feeding systems, the operation of the manure belts, the sounds made by the animals (biological noise), and the loud talking of the employees during work are among the noise sources. High noise levels may occur in mechanically ventilated farms. Providing the necessary ventilation to continuously maintain the air quality in the house environment constantly causes background noise (O'connor et al., 2011). No matter how short the noise periods are, the emergence of intense noise is an essential factor that stresses animals and also affects workers (Venglovsky et al., 2007; Onasanya et al., 2020). Noise; is defined as unwanted, disturbing and loud sounds (Broućek, 2014; EPA, 2021). When defining a sound as noise, the exposure of the receiver is important, whether it is listening or whether it causes unpleasant feelings in the receiver. At the same time, besides the duration, frequency, intensity and loudness of the sound, animal species, breeds, age, and physiological conditions of animals are also effective (Broućek, 2014).

As a result of exposure to noise in poultry causes psychological effects such as escaping from the herd and fighting with each other while increasing the cortisone level, causing behavioural disorders and fear in the animals (Girgin and Kılıç, 2020; Cockrem, 2007). When poultry is exposed to noise potentially causing fear, they may perch flat on the ground or show different behaviours such as slumping into a corner (Chloupek et al., 2009). The limit of the noise level in the poultry houses is not included in the regulation, however, three noise exposure limit values are specified in the Regulation on the Protection of Employees from Risks Related to Noise: The lowest exposure value is 80 dB(A), the highest exposure value is 85 dB(A), exposure limit value is 87 dB(A) (A-weighted daily noise exposure levels). In addition, with the Environmental Noise Evaluation and Management Regulation issued in 2010, it is aimed to determine the noise level and to reduce its effects on the environment. Noise causes temporary or permanent health problems by being exposed to noise levels above 75 dB(A), especially for people living in cities. In addition to hearing loss, it also causes both physical and psychological effects such as nervous and circulatory system disorders, hormonal imbalance, restlessness, concentration disorder, and fatigue (Kılıç et al., 2021).

This study aims to determine the noise level in a battery-cage layer hen farm in the Bursa region and to reveal the relationship between environmental conditions and noise in the henhouse.

MATERIAL AND METHOD

In the study, noise levels were measured periodically in the hen house for a year in a laying hen farm operating in the Bursa region.

A hand-held EXTECH SDL600 (Sound Level Meter) digital sound meter was used for noise measurement. The unit of decibel (dB) is used to measure the noise intensity (Figure 1). Studies on measuring noise pollution in livestock barns are very limited. There are hardly any studies on the poultry house, so there is no specific method for examining and determining noise pollution.

There were 3300 chickens in the hen at the beginning of the measurements, but there were 2900 chickens left at the end of the research, as there were dead chickens throughout the production process. There are three rows of cages in the examined henhouse, and each row of cages has 3 floors. Noise measurements were taken from each floor, and noise measurements were made from 12 different points. The measurements were measured from the same points in the cage rows, and the measurement conditions were preserved. At the measurement points in the 1st and 4th corridors, the noise measurement device was

measured directly adjacent to the cage, while the measurement was made from the middle of the two rows in the 2nd and 3rd corridors (Figure 2).

Figure 1. EXTECH SDL600 (Sound Level Meter) noise meter.
Şekil 1. EXTECH SDL600 (Ses Seviyesi Ölçer) gürültü ölçer.

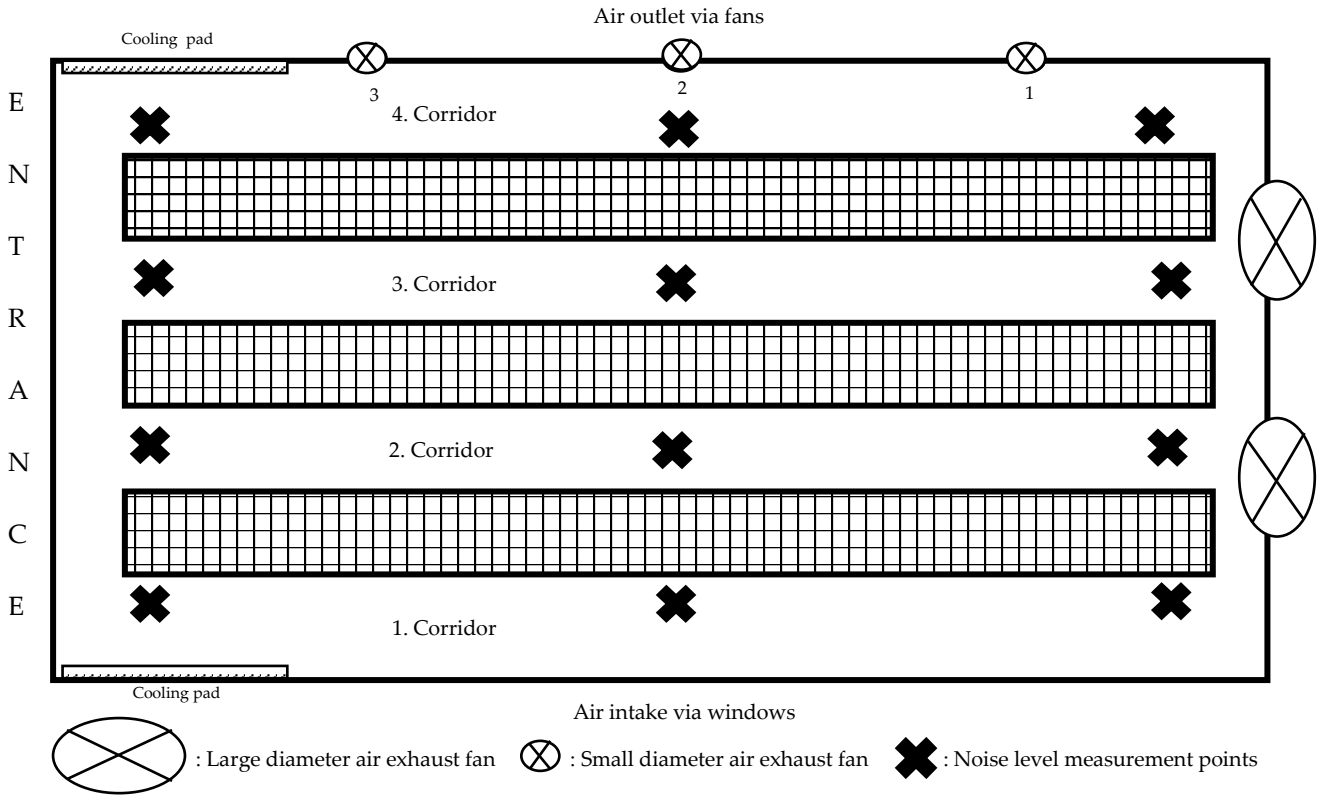

Figure 2. Perspective and noise measurement points in the henhouse.
Şekil 2. Kümesin perspektif görünümü ve gürültü ölçüm noktaları.

During the measurement periods, climatic data such as indoor temperature, humidity and air velocity in the poultry house were also recorded. In the study, the relationship between the noise levels measured using the SPSS statistical program and the climatic data was revealed by regression analysis.

RESULTS AND DISCUSSION

Noise Pollution Level

At the end of the henhouse, there are two large air exhaust fans with a diameter of 200 cm in this study monitored. Large fans provide air flow with a flow rate of approximately 18.000 m^3. It operates at 630 periods per minute with a sound of 67 dB(A). It has been monitored that in summer seasons, especially in the middle of the day, only one fan works at medium speed, but both do not work in cold seasons. It is operated only during the very hot seasons.

There are three small air exhaust fans with a diameter of 26 cm at the air outlet openings of the henhouse. The fans operate with a flow rate of approximately 1200 m^3/hour, making 1400 periods per minute, with a sound level of 70-73 dB(A). Fan-1 is working continuously throughout with year. Fan-2 usually worked in hot seasons with Fan-1. Fan-3 has not been observed to work throughout the year.

The outside noise level was also measured in the area where the poultry house is located. While the fan pads are operating in summer, 61 dB is measured at the air inlet opening, while the noise level measured at the air outlet opening is 60.2 dB. Hasan and Jamal (2021), stated that there is a consensus that exposure to noise levels lower than 70 dB(A) does not cause hearing problems regardless of exposure time. O'Connor et al. (2011) stated in their study that they showed lower egg laying efficiency compared to chickens exposed to 80 dB(A) noise and 60 dB(A) noise. The fan pads did generally not operate in conditions where it was not very hot. In this case, the noise intensity could not be measured because the outside noise level was below the minimum level to be measured by the device (60 dB).

Noise values were measured between February 2021 and January 2022. The feed distribution machines and egg belts are generally operated in the henhouse in the morning hours. The noise level was measured relatively higher during their operation. In Table 1, the noise values obtained from the measurement points in the corridors are given for months.

Table 1. Noise levels (dB) in the house according to the rows of cages.
Çizelge 1. Kafes katlarına göre kümesteki gürültü seviyeleri (dB).

		Corridor Head	Corridor Middle	Corridor End
Daily	1.Tier	68.7	70.5	71.3
	2. Tier	68.5	70.1	70.8
	3. Tier	68.6	70.0	70.4
Montly	1. Tier	68.5	70.3	71.1
	2. Tier	68.3	69.9	70.6
	3. Tier	68.4	69.9	70.2
Seasonal	1. Tier	68.4	70.3	71.2
	2. Tier	68.3	69.8	70.7
	3. Tier	68.4	69.8	70.3

The first measurement point (at the beginning) of the cage rows near the entrance, the measurement point at the mid-point (middle) of the cage rows, and the measurement point at the end of the cage rows (at the end) were measured at a total of 12 points in the house (Table 2). While the noise level was measured from the measurement points close to the outlet fans, the noises of the fans while they were running had a relative impact on the noise level.

Table 2. Noise levels (dB) in house cage rows by the corridors.
Çizelge 2. Koridorlara göre kümes kafesi sıralarındaki gürültü seviyeleri (dB).

		Corridor Head	Corridor Middle	Corridor End
Daily	1. Corridor	67.9	68.9	70.4
	2. Corridor	68.5	69.9	71.0
	3. Corridor	69.2	70.6	71.1
	4. Corridor	68.9	71.4	70.8
Montly	1. Corridor	67.7	68.7	70.3
	2. Corridor	68.2	69.7	70.7
	3. Corridor	69.0	70.3	70.8
	4. Corridor	68.6	71.2	70.4
Seasonal	1. Corridor	67.6	68.6	70.3
	2. Corridor	68.2	69.6	70.8
	3. Corridor	69.0	70.1	70.8
	4. Corridor	68.7	70.7	70.7

Statistical Evaluation of Noise Data

The statistical significance of the differences between the noise values measured during the study was determined by analysis of variance. The significance of the differences between the season, month, corridor, floors and location was determined by one-way and multi-way analysis of the variance of the measured values. Statistical analyzes were performed using SPSS 23 computer software. The results of the analysis of variance are given in Table 3. According to Table 3, the difference between the points where noise measurements were made is statistically significant ($P<0.05$). Especially the measurements made at the beginning of the corridor near the entrance of the poultry house were lower. The differences between the noise values measured between the cage tiers in the examined house were found to be statistically significant ($P<0.05$). The highest value among the floors was obtained on the 1st floor, while the lowest was obtained on the 3rd floor. Since the density of animals on the third floor is less than on the first floor, the lowest values were obtained here. The differences between the months and seasons measured in the study were statistically significant ($P<0.05$).

Table 3. Variance analysis of noise measurements.
Çizelge 3. Gürültü ölçümlerinin varyans analizi.

Factor	Degree	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Location	**Head**	68.61^{c}	2.76	0.12	68.39	68.84	60.40	80.10
	Middle	70.19^{b}	2.51	0.11	69.98	70.40	62.20	79.30
	End	70.84^{a}	2.47	0.10	70.64	71.05	60.60	80.60
	Avg	69.88	2.74	0.07	69.75	70.01	60.40	80.60
Tier	**1.00**	70.15^{a}	2.75	0.12	69.93	70.38	60.40	79.60
	2.00	69.81^{ab}	2.73	0.11	69.58	70.03	61.30	80.10
	3.00	69.68^{ab}	2.74	0.12	69.46	69.91	61.50	80.60
	Avg	69.88	2.74	0.07	69.75	70.01	60.40	80.60

Table 3. Continue.
Çizelge 3. Devamı.

Factor	Degree	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Corridor	1.00	69.10[c]	3.16	0.15	68.80	69.40	60.40	80.60
	2.00	69.78[b]	2.58	0.13	69.54	70.03	60.60	77.30
	3.00	70.26[a]	2.48	0.12	70.03	70.50	61.60	79.10
	4.00	70.38[a]	2.52	0.12	70.14	70.62	63.40	79.30
	Avg	69.88	2.74	0.07	69.75	70.01	60.40	80.60
Month	December	69.77[c]	2.71	0.20	69.37	70.17	64.10	79.30
	January	69.75[c]	2.62	0.20	69.37	70.14	61.30	77.70
	February	69.02[c]	2.15	0.18	68.67	69.38	61.60	74.10
	March	69.10[c]	2.68	0.26	68.59	69.61	62.20	74.50
	April	68.75[d]	2.87	0.28	68.21	69.30	61.30	75.60
	May	70.07[b]	2.74	0.26	69.55	70.59	65.00	80.60
	June	70.51[b]	2.13	0.18	70.16	70.86	63.50	78.30
	July	70.63[b]	2.47	0.18	70.26	70.99	63.80	77.60
	August	70.41[b]	3.03	0.29	69.83	70.99	60.40	76.10
	September	69.50[c]	2.33	0.19	69.11	69.88	64.70	75.30
	October	71.79[a]	2.72	0.20	71.39	72.19	63.90	80.10
	November	67.87[e]	2.41	0.23	67.41	68.33	61.30	74.10
	Avg	69.88	2.74	0.07	69.75	70.01	60.40	80.60
Season	Winter	70.11[a]	3.05	0.14	69.83	70.38	61.30	80.10
	Spring	69.35[b]	2.51	0.12	69.11	69.58	61.30	77.70
	Summer	69.85[a]	2.65	0.14	69.58	70.13	61.30	80.60
	Autumn	70.20[a]	2.62	0.13	69.95	70.44	60.40	77.60
	Avg	69.88	2.74	0.07	69.75	70.01	60.40	80.60

*Farklı harfler ile gösterilen ortalamalar arasındaki farklar istatistiksel olarak P<0.05 seviyesinde önemlidir.

Relationship between Noise Level and Indoor Climatic Conditions

In the study, multivariate regression analysis was performed with the help of the SPSS statistical program to determine whether the climatic conditions in the poultry house affect noise pollution.

Multiple regression analysis was carried out to determine the effect of climatic conditions in the hen house on the noise values in the measured houses. In this analysis, parameters such as temperature, relative humidity, and air velocity measured in the same period as noise were taken as climatic factors. According to the analysis results, R^2 values showing the relationship between temperature, relative humidity and air velocity were obtained as 0.20, 0.30, 0.40, respectively. Therefore, it can be said that there is no significant relationship between noise and climatic environmental conditions.

When the noise level measured in the hen house is examined on a seasonal basis, it has been observed that animals and workers are exposed to more noise in summer and hot seasons (Figure 3-4). This is because the large fans at the end of the henhouse and the air outlet fans work continuously during the day. In addition, in hot seasons, mobility increases in heat-affected animals. This situation also increases the noise level caused by laying hen. The relative humidity in the house showed a linear relationship depending on the temperature, and values between 60% and 55% were obtained.

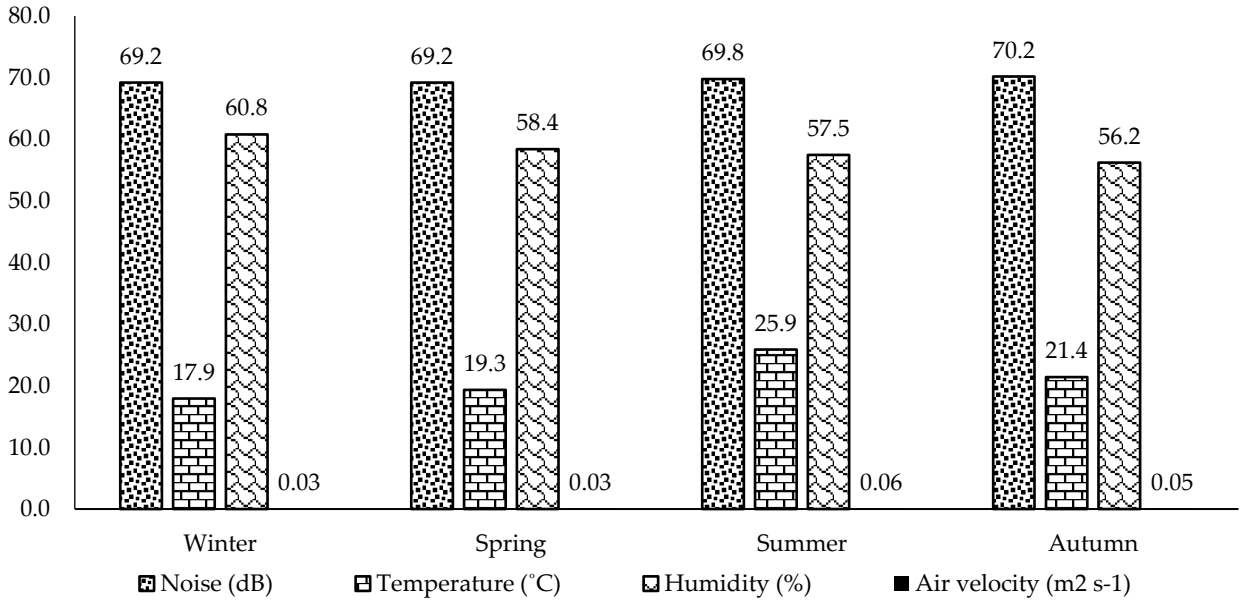

Figure 3. Average noise intensity and climatic conditions based on seasons.
Şekil 3. Mevsimlere göre ortalama gürültü yoğunluğu ve iklim koşulları.

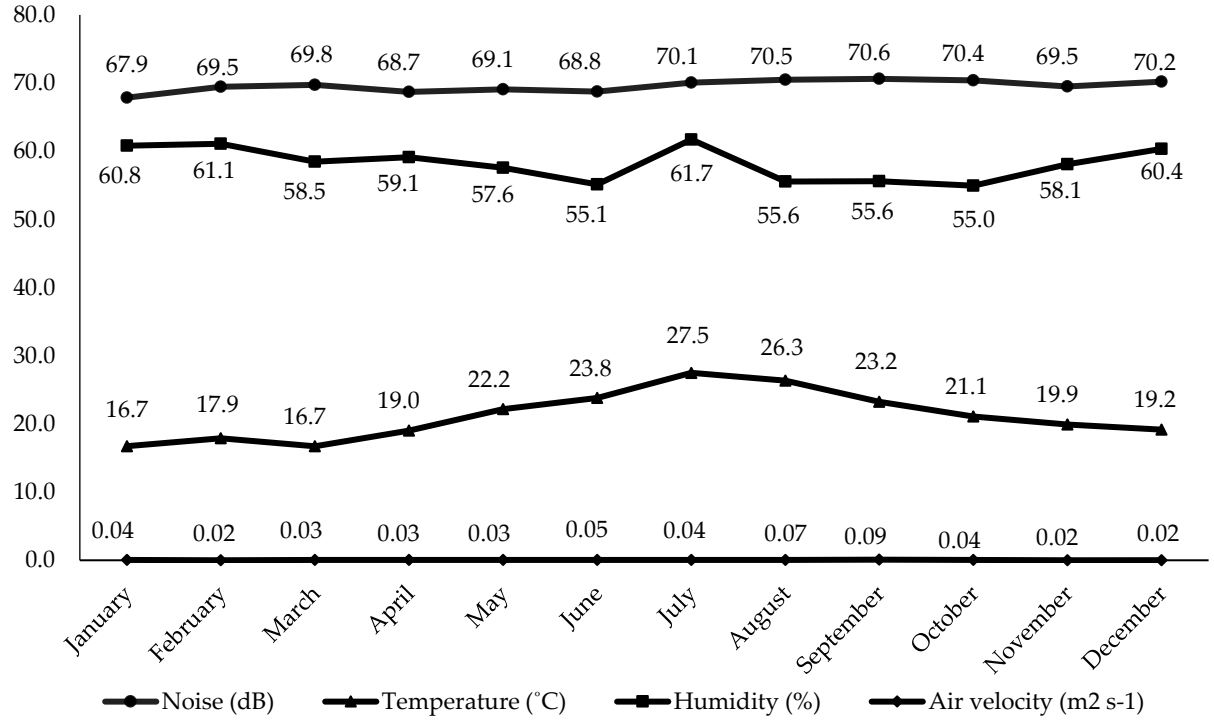

Figure 4. Average noise intensity and climatic data according to months.
Şekil 4. Aylara göre ortalama gürültü şiddeti ve iklim verileri.

Relationship between Noise Level and Egg productivity

During the study period, it was observed that the noise level was higher due to the operation of the fans and fan pads in hot periods (Table 4). In the study, there was a decrease in egg production in the periods when the noise level was higher (Figure 5a). There is also a decrease in the number of hens (Figure 5b). Brouček (2014) stated in his study that egg production decreases in poultry that are usually exposed to sudden or intense noise. It is seen that noise affects efficiency. However, it is not a correct approach to

associate egg productivity only with noise. It can be said that the passing of the production periods in which chickens are productive and other environmental conditions such as temperature are also effective in decreasing productivity.

Table 4. Noise-egg-hen values during the study period.
Çizelge 4. Çalışma süresi boyunca gürültü-yumurta-tavuk sayısı değerleri.

	Noise Level (dB)	Egg (viol)	Hen (number)
January	69.8	3346	3300
February	69.0	3344	3300
March	69.1	3349	3300
April	68.8	3339	4053
May	70.1	3358	4015
June	70.5	3320	3980
July	70.6	3224	3980
August	70.4	3152	3925
September	69.5	2812	3763
October	71.8	2471	3600
November	67.9	2266	3500
December	69.8	1581	3400

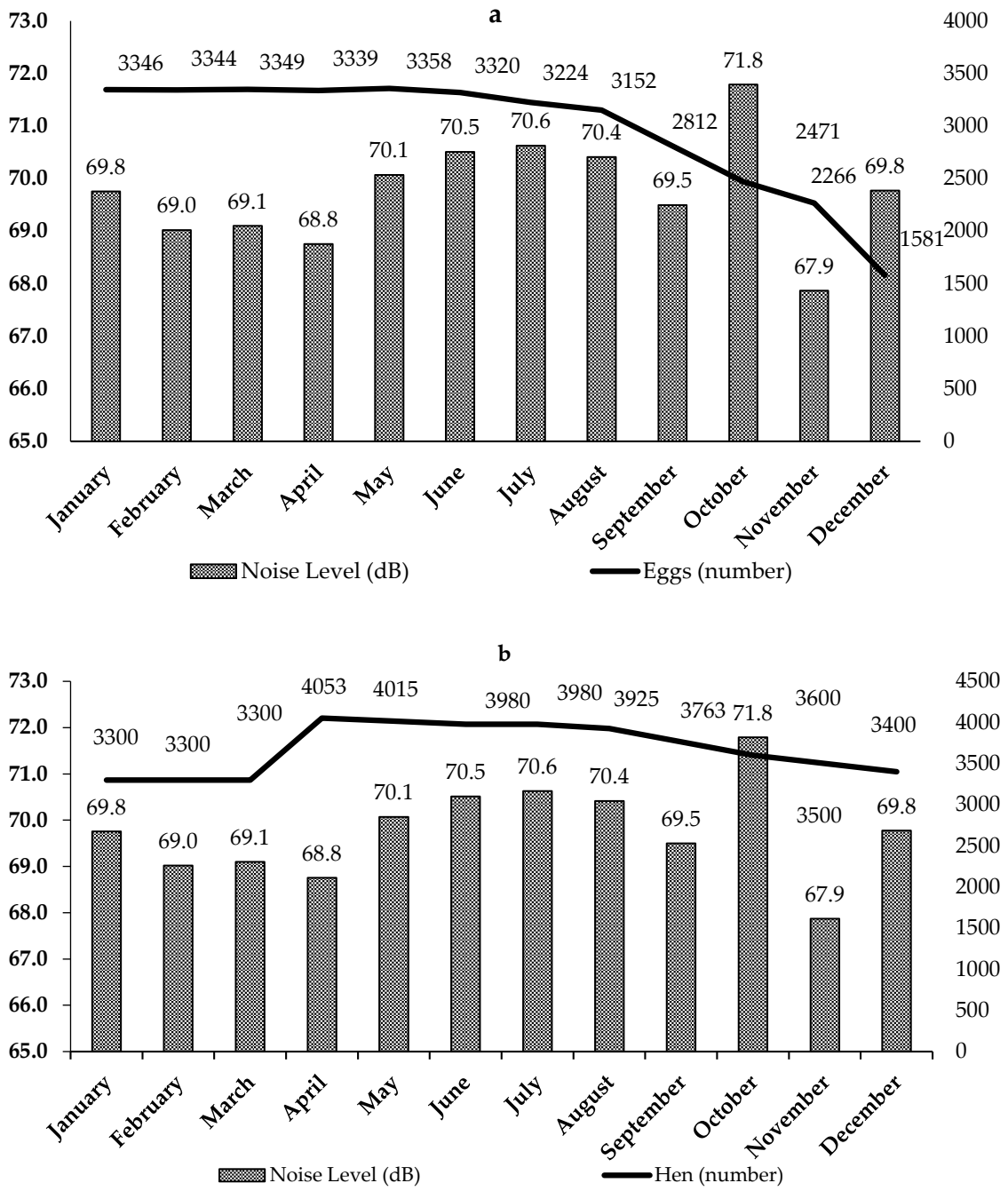

Figure 5. Noise-egg number variation (a), Noise-hen number variation (b).
Şekil 5. Gürültü-Yumurta sayısı değişimi (a), Gürültü-tavuk sayısı değişimi (b).

CONCLUSION

This study constitutes a method and a resource for future studies in terms of revealing noise pollution in the poultry house and focusing on the affecting factors. No regulation or article sets out a certain level or minimum level of noise intensity for poultry houses. Only in the regulation named "Regulation on Minimum Standards for the Protection of Laying Hens" it is stated that ventilation fans, feeding machines, manure belt operation and other equipment in the poultry house should be constructed, operated and maintained in such a way as to work with minimum noise. In addition, keeping the climatic conditions at an ideal level in the henhouse will ensure animal comfort and welfare, and animals that are not stressed

will be calmer, so the effect to noise pollution will be reduced. More research is needed to explore noise-related factors and their effects within modern commercial poultry farms.

CONFLICT OF INTEREST

Authors declared no conflict interest.

DECLARATION OF AUTHOR CONTRIBUTION

The authors contributed equally to the article.

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