The impact of gender on growth performance, live weight gain, and survival rate in Pekin ducks

Research Article

ABSTRACT

This study aimed to investigate the effect of gender on growth performance, live weight gain, and survival rate in Pekin ducks raised in a family-type farm in Kars province. A total of 150 ducklings (62 males, 88 females) were observed from day one. Weight measurements were recorded regularly, and mortalities were noted for survival rate analysis. No significant gender differences were observed in live weight up to 10 weeks of age, indicating comparable growth rates initially. However, at 10, 13, and 16 weeks, male ducks had higher live weights compared to females. Daily live weight gains were significantly higher during the first two weeks, with a decreasing trend as the ducks grew older. Gender significantly affected daily weight gains during the initial two weeks. The influence of gender on weekly live weight gains was not statistically significant. Live weight gains decreased over time, while overall live weight increased. Regression models indicated higher growth rates in males. Survival rates remained high throughout the 16-week period, with no significant difference between genders. The hazard ratio analysis suggested no substantial difference in mortality risk between male and female ducks. In conclusion, gender influenced live weight and daily weight gains in Pekin ducks, with males generally exhibiting higher weights. However, gender did not significantly affect average live weight gain and survival rates.

Keywords: Gender, growth performance, live weight gain, Pekin duck, survival

Buket Boğa Kuru[1a]
Turgut Kırmızıbayrak[2b]

[1] Department of Animal Breeding and Husbandry, Faculty of Veterinary Medicine, Kafkas University, Kars, Türkiye

ORCİD-
[a]0000-0002-7170-270X
[b]0000-0003-3626-6137

Correspondence
Buket Boğa Kuru
buketboga@gmail.com

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INTRODUCTION

Ducks, especially Pekin ducks, hold significant importance as a commercial poultry species in the global market. The meat duck industry has experienced rapid growth, witnessing a substantial surge in recent years. Asia, France, Myanmar, the United States, and the United Kingdom are among the leading regions in duck meat production. Pekin ducks, known for their rapid growth, are widely bred due to their ability to quickly reach the desired market weight. On the other hand, Muscovy ducks have a slower growth rate, lower fat content, and exhibit variations in body weight based on gender (Chen et al., 2021; Huang et al., 2012). The growth and development of Pekin ducks, the most widely used domestic duck breed in commercial settings, are influenced by various factors (Cherry & Morris, 2008; Debnath, 2022; Su, 2022). Genetics, nutrition, environment, and management practices all play a crucial role in their growth. Genetic factors significantly impact growth, body composition, bone development, muscle mass, and feather structure. Nutrition, including a balanced diet with adequate protein, energy, vitamins, and minerals, is vital for optimal growth. Environmental factors such as temperature, humidity, air quality, and lighting also affect growth. Providing favorable conditions reduces stress and promotes healthy growth (Cherry & Morris, 2008; Debnath, 2022; Jalaludeen & Churchil, 2022).

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When provided with the appropriate genotype and optimal conditions, Pekin ducks can achieve an average weight of 3.3 to 3.7 kg at 6-8 weeks of age. This represents a substantial weight gain within a relatively short time frame. Additionally, the feed conversion ratio has been improved to a range of 1.88 to 1.97, indicating a more efficient utilization of feed for weight gain. These improvements in growth performance are the result of continuous selection and breeding programs that prioritize traits associated with rapid growth and enhanced feed efficiency. The objective is to meet the market demand for larger, well-developed ducks within a shorter production cycle. The ongoing enhancements in the growth performance of Pekin ducks highlight the importance of genetic selection and advancements in the poultry industry. Not only have these developments increased productivity, but they have also contributed to the economic viability of Pekin duck farming (Debnath, 2022; Huang et al., 2012; Jalaludeen & Churchil, 2022; Su, 2022).

The aim of this study is to investigate the effect of gender on growth performance, live weight gain, and survival rate in Pekin ducks raised in a family-type farm located in Kars province, Türkiye. The study aims to determine potential differences in growth and live weight gain based on gender and provide better insights to breeders. Additionally, the impact of gender on the survival rate of ducks will also be evaluated. The obtained results will guide practical applications for farm owners and researchers engaged in Pekin duck farming.

MATERIALS AND METHODS

Location

The study was conducted in the province of Kars, which is located at coordinates 40°36'18"N and 43°5'48"E, at an altitude of 1760 meters above sea level. Kars province is situated in the easternmost region of Türkiye and shares a border with Armenia.

Animal and feeds

In the conducted study, a cohort of 150 Pekin ducks was examined, comprising 62 males and 88 females. The ducklings, which were only one day old, were placed in heated brooder batteries with continuous lighting, ensuring consistent environmental conditions for all individuals. The male and female ducklings were subsequently relocated to floor pens equipped with deep bedding, where they were provided with wooden shavings measuring approximately 8-10 cm in thickness as their bedding material. The pens maintained a stocking density of 4 ducklings per square meter.

Starting from the second week onwards, the ducklings were exposed to a light-dark cycle consisting of 16 hours of light followed by 8 hours of darkness each day. Initially, during the first week, the ambient temperature was carefully set at a range of 32-34°C. Subsequently, over subsequent weeks, the temperature gradually decreased by approximately 3-5°C per week. By the conclusion of the 28-day period, the ambient temperature was successfully reduced to a minimum level of 19-20°C. Subsequently, the ducklings were transferred to an environment with free-range access, providing them the opportunity to explore and grow in a more unrestricted setting.

All ducks were fed *ad libitum* diets during the initial four weeks, containing 22% crude protein and 3000 kcal/kg of metabolizable energy. Subsequently, from weeks 5 to 16, ducks were subjected to restricted feeding (Cherry, 1993) with diets containing 18% crude protein and 3100 kcal/kg of metabolizable energy. This approach adhered to the conventional method employed by the farmers (Debnath, 2022), without any modifications or supplementation. Throughout the entire experimental period, ducks had *ad libitum* access to water.

The live weights of ducklings were measured every two weeks during the initial four-week

period following hatch, and then every three weeks until they reached 16 weeks of age. These weight measurements were conducted to determine their growth progress. Additionally, any mortalities that occurred during the respective periods were recorded to calculate the survival rate, thereby assessing the overall health and viability of the ducklings in the study.

Statistical analyses

The normal distribution of the data was assessed visually through histogram and Q-Q plot methods, as well as statistically tested using the Kolmogorov-Smirnov test based on the sampling weeks. This comprehensive analysis confirmed that the data exhibited a normal distribution, ensuring the validity of subsequent parametric statistical tests. To determine the effects of gender on the daily or weekly live weight gains and their impact on growth performance, a two-way analysis of variance (ANOVA) was employed. The significance of differences identified through the ANOVA in multiple comparisons was assessed using the Tukey post hoc test. Data obtained only from surviving animals after hatch were included in the analyses. Linear regression models and Gompertz growth curve models were developed to examine the relationship between gender and live weights. Additionally, Kaplan-Meier survival curve analysis was conducted by recording the outcomes of deaths and survivals according to sampling weeks. The statistical software GraphPad Prism® version 9.5.1 (GraphPad Software Inc., San Diego, CA, USA) was utilized for performing the analyses. The data were presented as mean ± standard error of the mean (SEM), and statistical significance was determined at a threshold of $P < 0.05$.

RESULTS

Detailed information regarding the mean live weights of Pekin ducks at different weighing weeks can be found in Table 1.

The average hatching weights of male and female Pekin ducklings were found to be 47.5 ± 0.8 g and 45.7 ± 0.5 g, respectively ($P > 0.05$, Table 1). Interestingly, there was no statistically significant difference between male and female ducks up to 10 weeks of age, indicating comparable growth rates during this early stage (Figure 1A, $P > 0.05$). However, a two-way analysis of variance revealed that gender had a significant impact on the overall live weight of Pekin ducks ($P < 0.001$, Figure 1A). Moreover, at 10, 13, and 16 weeks, there were notable differences in live weights between male and female ducks ($P < 0.05$, Figure 1A). By the 16th week, male Pekin ducks exhibited an average live weight of 2142.3 ± 30.6 g, while their female counterparts weighed an average of 2049.0 ± 23.1 g (Table 1).

The average daily live weight gains varying with the weighing weeks in Pekin ducks are provided in Table 1. During the first two weeks of their growth, Pekin ducklings exhibited significantly higher daily live weight gains compared to the subsequent sampling weeks (Table 1). However, as they advanced in age, there was a noticeable trend of decreasing daily weight gain. Notably, a two-way analysis of variance revealed that the gender of Pekin ducks had a significant impact on their daily live weight gain ($P < 0.001$, Figure 1B). Specifically, male and female ducklings displayed statistically significant differences in their daily weight gains, particularly during the initial two-week period ($P < 0.05$, Figure 1B).

Investigating the influence of gender on the average daily live weight gain across weighing week intervals (Figure 1C) and the weekly live weight gains (Figure 1D) in Pekin ducks, it was determined that gender did not exhibit a statistically significant effect ($P > 0.05$). However, the data revealed a noteworthy surge in live weight gains during the initial two weeks of growth (Table 1).

Table 1. Growth performance and changes in live weight gain in Pekin ducks according to weighing weeks.

Parameters	Week	Male		Female	
		Mean ± SEM	n	Mean ± SEM	n
Live weight	0	47.5 ± 0.8	62	45.7 ± 0.5	88
	2	747.7 ± 18.3	57	699.7 ± 13.8	83
	4	971.4 ± 24.9	57	924.1 ± 19.4	81
	7	1303.8 ± 28.4	56	1233.2 ± 20.4	79
	10*	1633.9 ± 34.1	55	1531.9 ± 26.5	76
	13*	1881.2 ± 33.5	54	1788.2 ± 25.3	74
	16*	2142.3 ± 30.6	53	2049.0 ± 23.1	74
The daily live weight gain until the weighing week	0-2*	50.0 ± 1.3	57	46.7 ± 1.0	83
	0-4	33.0 ± 0.9	57	31.4 ± 0.7	81
	0-7	25.6 ± 0.6	56	24.2 ± 0.4	79
	0-10	22.7 ± 0.5	55	21.2 ± 0.4	76
	0-13	20.1 ± 0.4	54	19.2 ± 0.3	74
	0-16	18.7 ± 0.3	53	17.9 ± 0.2	74
Daily live weight gain	0-2	50.0 ± 1.3	57	46.7 ± 1.0	83
	2-4	16.3 ± 0.9	56	16.4 ± 0.8	80
	4-7	15.3 ± 1.0	56	14.1 ± 0.6	79
	7-10	15.6 ± 0.9	55	14.5 ± 0.6	76
	10-13	11.9 ± 1.0	54	11.8 ± 0.8	74
	13-16	12.3 ± 1.1	53	12.5 ± 1.0	74
Weekly live weight gain	0-2	699.8 ± 17.9	57	653.9 ± 13.8	83
	2-4	227.8 ± 13.0	56	229.6 ± 11.9	80
	4-7	320.9 ± 20.5	56	296.6 ± 12.5	79
	7-10	328.1 ± 18.4	55	305.0 ± 12.5	76
	10-13	249.7 ± 21.4	54	247.9 ± 15.9	74
	13-16	264.2 ± 23.2	52	270.7 ± 19.9	72

SEM: Standard error of mean. *: Indicates a statistically significant difference between genders within the same line ($P < 0.05$).

Despite the implementation of restricted feeding practices in traditionally reared Pekin ducks under family farm conditions, the study observed continuous growth and live weight gain over the 16-week period (Table 1). Notably, as time progressed, the rate of live weight gain exhibited a declining trend, while the overall live weight of the ducks continued to increase.

Based on the weighing weeks, the regression coefficient for males was higher than that for females in both the linear regression model (Figure 2A) and the Gompertz growth model (Figure 2B). These models revealed the influence of age on live weight gain. Notably, as age increased, the patterns of live weight gain became more apparent. Furthermore, the gender-specific formulas obtained for age-related changes are presented in Figure 2.

The Kaplan-Meier survival curve illustrates the survival rates of male and female Pekin ducks from the day of hatching to 16 weeks of age (Figure 3).

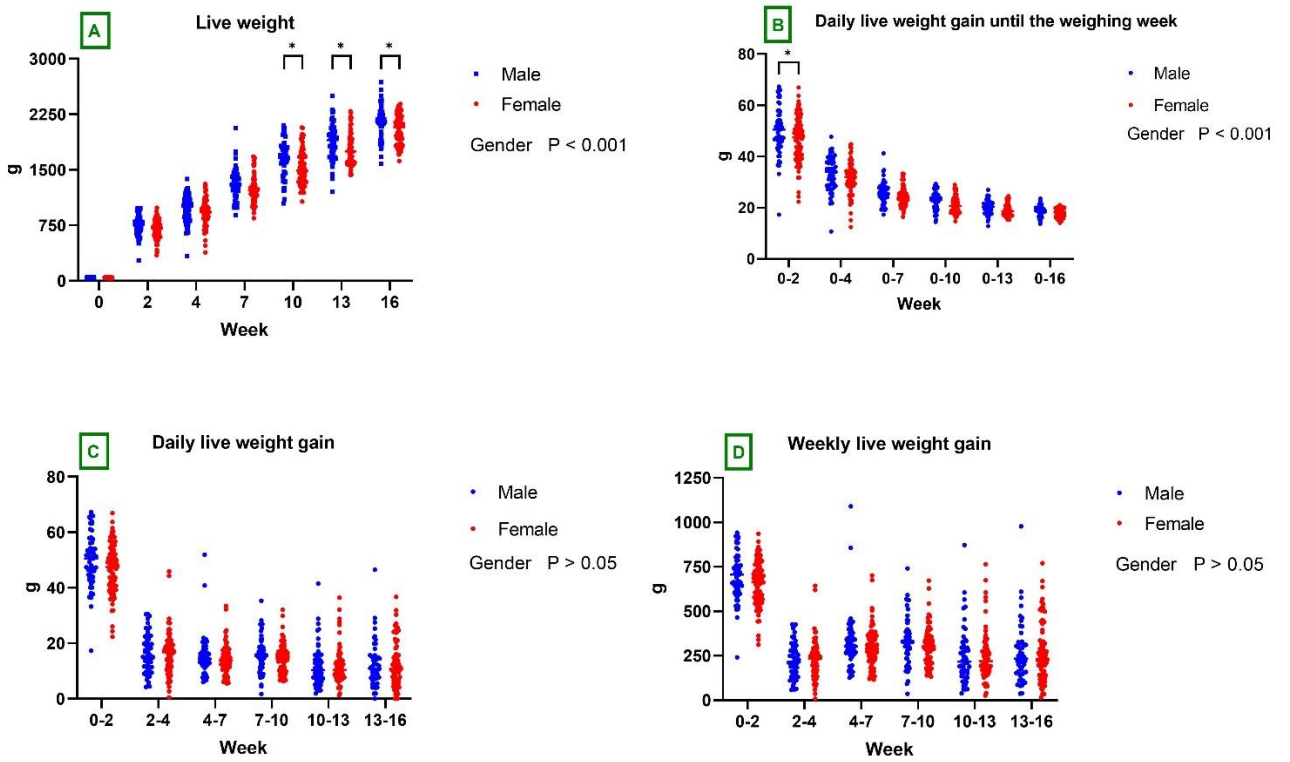

Figure 1. The growth performance (A), the daily live weight gain until the weighing week (B), daily live weight gain (C), and weekly live weight gain (D) of Pekin ducks across different weighing weeks. Our findings revealed a significant impact of gender on the growth performance of Pekin ducks. Specifically, at weeks 10, 13, and 16, male Pekin ducks exhibited higher live weights compared to females, and this difference was statistically significant (A). Additionally, the initial two-week period emerged as a crucial phase for live weight gain, characterized by substantial increases in weight. Moreover, our analysis suggested that gender could play a role in influencing live weight gain (B). Notably, there was a statistically significant difference in live weight gain between genders during the initial two weeks (B). *: $P < 0.05$

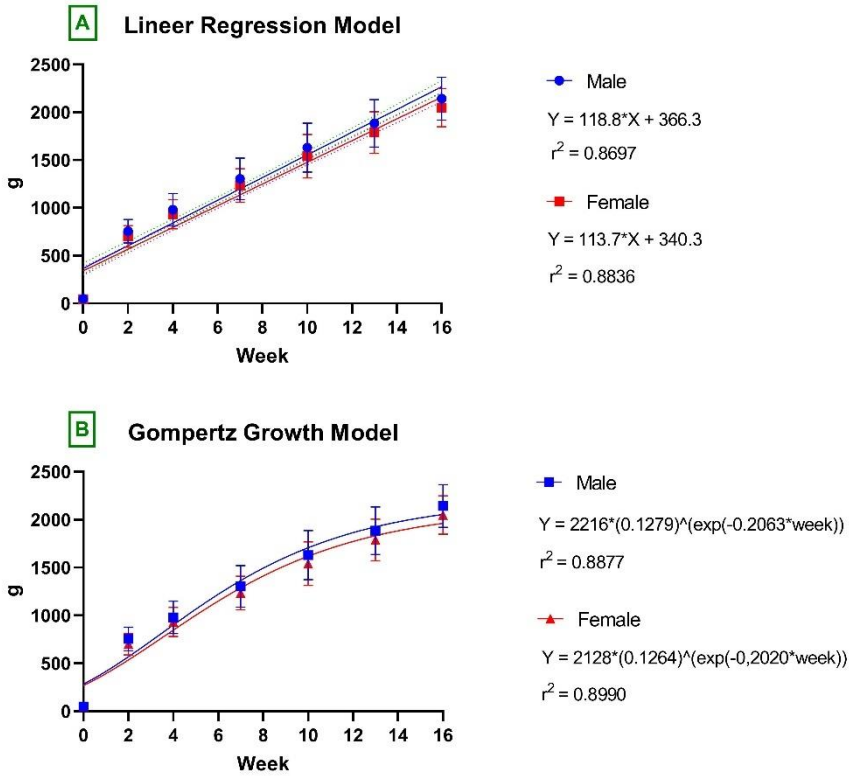

Figure 2. Growth curves of live body weight for male and female Pekin ducks according to linear regression model and Gompertz growth model.

The probability of survival gradually declines as the ducks approach the 16-week ages. However, the statistical analysis reveals that there is no significant decrease in survival rates throughout the 16-week period following hatching. At the conclusion of the 16-week timeframe, the survival rates were observed to be 86.9% for males and 84.2% for females, with no statistically significant difference between the genders ($P > 0.05$, Figure 3). Furthermore, the hazard ratio was calculated as 0.8195, with a 95% confidence interval ranging from 0.3458 to 1.942 and P-value was determined as 0.66. These findings suggest that there is no substantial difference in the risk of mortality between male and female Pekin ducks during the observed period.

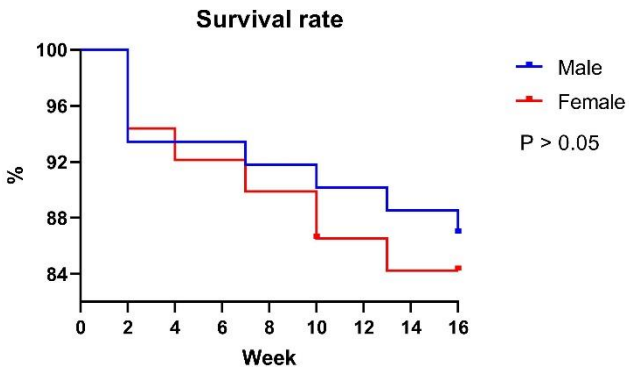

Figure 3. The Kaplan-Meier survival curve illustrates the survival rates of Pekin ducks from hatch to 16 weeks of age. The analysis reveals that there is no substantial decrease in survival rates over the 16-week period following hatch, indicating a relatively stable survival trend during this duration. The hazard ratio is calculated as 0.8195, with a 95% confidence interval ranging from 0.3458 to 1.942 and P = 0.66.

DISCUSSION

Ducks play a vital role in the agricultural systems of many developing countries, where they contribute significantly to meeting daily protein requirements and generating additional income for farming households. Typically, duck farming is primarily undertaken by family members, especially in rural areas. However, there has been a noticeable decline in duck farming in recent years. This decline can be attributed to various factors, including natural feed resources, the depletion of natural water sources, and the excessive use of pesticides in agricultural fields. The conservation and sustainable management of ducks and other waterfowl are crucial for ensuring global food security (Jalaludeen & Churchil, 2022; Pingel, 2011). In many regions, duck farming continues to be carried out in a traditional system; it is reported that location-specific technological interventions are needed to improve the existing practices (Debnath, 2022; Rahman et al., 2017). We conducted this study in a small-scale family farm located in Kars province, aiming to assess the growth performance, daily live weight gain, and survival rates of Pekin ducks raised under a free-range system using traditional methods. For the first four weeks, the ducks were provided with unlimited access to feed, followed by a transition to restricted feeding based on traditional farm practices until they reached 16 weeks of age. Importantly, we maintained a hands-off approach to the feeding regime throughout the study. It was observed that in family farms in the Kars region, feeding of ducks can continue until 20 weeks of age, after which they are slaughtered (Sarı et al., 2012).

In various studies on Pekin ducks, the average live weight at different ages has been documented. For instance, at 6 weeks of age, the reported average live weight ranges from 1214-1218 g (Zhang et al., 2018) to 2812-2904 g (Yan et al., 2020). Similarly, at 7 weeks of age, the average live weight is documented as 1692-1785 g (İşgüzar, 2006) to 3281-3461 g (Abo Ghanima et al., 2020), while at 8 weeks of age, it ranges from 2364-2568 g (Sari et al., 2013). At 10 weeks of age, the average live weight is reported as 1347-2143 g (Osman, 1993), and at 20 weeks of age, it ranges from 2457-2346 g (Sarı et al., 2012). In modern farms with ad libitum feeding, it is noted that Pekin ducks can reach an average live weight of 3.27-3.55 kg by 42 days of age (Cherry & Morris, 2008; Debnath, 2022; Jalaludeen & Churchil, 2022; Su, 2022). However, our study observed that the average live weight at 16 weeks of age ranged from 2049

to 2142 g, which is noticeably lower than the average values reported for modern farming at 6 or 7 weeks of age. It is worth mentioning that studies with limited feeding, similar to ours, have reported live weight ranges of 1792-2007 g at 12 weeks of age (Işguzar et al., 2002) and approximately 2.4 kg at 16 weeks of age (Cherry, 1993). The differences in live weight observed in our study can be attributed to both the variations in feeding methods and the fact that the ducks were raised under a free-range system. Additionally, it is important to consider that the growth performance of Pekin ducks can be influenced by the specific genotypes used in the studies.

In our study, we investigated the impact of gender on live weight changes in Pekin ducks over different sampling weeks. The results revealed a significant effect of gender on live weight, particularly during the 10-16-week period, where male ducks exhibited higher live weights compared to females. Additionally, male ducklings showed higher daily live weight gain in the first two weeks of the study. These results are consistent with previous studies (Erdem et al., 2015; Işguzar et al., 2002; Sari et al., 2013; Tığlı et al., 1991) that have reported gender-related differences in live weight, with male Pekin ducks generally having higher weights at slaughter time. Moreover, similar to our findings, it has been observed that gender can influence live weight gain during the early weeks after hatching (Erdem et al., 2015; Erdem & Akçapınar, 2012; Işguzar et al., 2002). Factors such as hatch weight and genotype are believed to play a significant role in these gender-related differences. Several studies conducted on Pekin ducks have demonstrated that both genotype and gender can impact growth performance and live weight gain (Kokoszyński et al., 2015, 2019). Furthermore, our study revealed a noticeable trend of increasing body weight with age in Pekin ducks, with significant interactions between age and gender. Male ducks consistently exhibited higher weights compared to females throughout the different weeks, and the period of highest body weight gain was observed to be the first three weeks of life (Onbaşılar et al., 2011). However, it is important to note that after the initial four weeks, the significant daily weight gains observed in the early weeks gradually decreased. This discrepancy in live weight gains compared to intensive modern farming practices may be attributed to differences in both feeding and rearing conditions. Therefore, it is crucial to modernize and optimize both management practices and feeding preferences to enhance daily live weight gains and maximize economic benefits in Pekin duck farming.

Modeling growth curves in scientific studies allows us to gain valuable insights into the patterns of growth over time and provides us with predictive equations to estimate the expected weight of animals at different ages. Numerous growth models have been developed to examine the complex relationship between age and body weight in animals (Kokoszyński et al., 2019; Maruyama et al., 2010; Onbaşılar et al., 2011). In our study, we employed two widely used models, namely the linear regression and Gompertz growth models, to analyze and forecast body weight changes over time. Intriguingly, we observed that male individuals exhibited a higher regression coefficient compared to female, suggesting potential gender-based variations in growth. Furthermore, both models consistently demonstrated that body weight tends to increase as animals age, indicating the importance of considering age as a critical factor in understanding growth dynamics.

Under normal rearing conditions, the mortality rates of ducks between 1-5 months of age are approximately 10%. This mortality can be attributed to various factors such as predator

attacks, mycotoxin contamination in feed, parasitic infections, pesticide levels in feed, feed availability, and disease outbreaks like duck plague, duck cholera, and avian influenza (Cherry & Morris, 2008; Sankaralingam & Mahanta, 2022). As ducks reach 8 weeks of age, the mortality rate typically decreases to below 10%, although it may still vary within the range of 10-20% (Sankaralingam & Mahanta, 2022). It is noteworthy that the 0-8 week period holds particular significance in duck farming, with mortality rates ranging from 2-3% (Debnath, 2022). In the context of Pekin ducks, a species-specific study reported a mortality rate of approximately 4-9% until the day of slaughter (Erisir et al., 2009). In the present study, employing Kaplan-Meier survival curve analysis, we observed mortality rates of 14.5% for males and 15.9% for females. Furthermore, our investigation underscores the crucial necessity of meticulously monitoring the mortality rate throughout the 16-week interval following the hatching of Pekin ducks. Nevertheless, gender did not exhibit a statistically significant impact on the observed mortality rate among Pekin ducks.

CONCLUSION

In conclusion, the gender of Pekin ducks raised in family-type farms in Kars province has been found to impact their growth performance. However, no significant difference was observed in terms of survival rate between male and female ducks. It is worth noting that during the 16-week monitoring period, the live weights of these ducks were notably lower compared to the data obtained from Pekin ducks raised in modern farms. This difference in growth performance can be attributed to the negative effects of traditional methods and restricted feeding practices commonly employed in family-type farms. To address these challenges and improve the growth performance of ducks in family-type farms, it is highly recommended to provide education and seminars on modern farming conditions and care standards. By equipping farming families with knowledge about optimal farming practices, they can enhance the well-being and growth potential of their ducks. Additionally, conducting comparative studies in the future that encompass both traditional and modern farming conditions would be valuable. Such studies would highlight the potential economic benefits that farming families can achieve by adopting higher growth performance practices observed in modern farming conditions.

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Conflict of interest: The authors declared that there is no conflict of interest.

Ethical statement: This study was carried out after the approval obtained from the Kafkas University Animal Experiments Ethics Committee, (KAÜ-HADYEK / 2021-107) and the permission obtained from The Turkish Ministry of Agriculture and Forestry.

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