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Non-ruminants

Live weight and body measurements of male and female native ducks raised in different raising systems

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ABSTRACT - The purpose of this study was to determine live weight and body measurements of male and female native ducks raised in different raising systems. One hundred and twenty native ducks (60 males, 60 females) were used in the study. The ducks were raised in deep litter floor and cage systems. Live weight and body values were measured every two weeks, until they were 56 days old. Three-parameter logistic regression and Gompertz model were used to determine growth model of male and female ducks. Interactions of time-raising system and time-sex were statistically significant in terms of live weight. At the end of eight weeks, live weights of ducks raised in deep litter floor were higher than ducks raised in cage system. In addition, live weights of male ducks were higher than female ducks. Consequently, deep litter floor is more appropriate for live weight in native ducks. Accuracy rate of Three-parameter Logistic and Gompertz models for estimation of growth in ducks was between 0.91-0.95 and similar results were obtained from both models. The Gompertz model is appropriate for the data structure of this study because it contains fewer iterations than the Three-Parameter Logistic model.

Key Words: cage system, deep litter floor, growth model, Gompertz, Three-Parameter Logistic

Introduction

Protein sources obtained from poultry have a great importance in human nutrition. In addition to other poultry, it is also required to develop sources of duck raising and conduct studies on production of these sources in a more economical way for humans to eat well. Even though chicken is the primary among poultry species raised in Turkey, duck raising is also performed. The number of ducks in Turkey was 491,561 according to data of 2017 (Tuik, 2018). The reasons for preferring duck are: it is easy to breed, adapts to different environmental conditions, and is more resistant to respiratory tract diseases such as infectious bronchitis than other poultry. Therefore, the importance of duck raising has increased gradually as well (Ensminger, 1992; Oluyemi and Olobobo, 1997; Solomon et al., 2006). Ducks are usually raised in intensive system without pool (Selcuk and Akyurt, 1986). However, there are also different raising systems for ducks. These systems are divided into three groups; free-range (extensive), semi-intensive, and intensive. Intensive system includes deep litter and cage systems. In these systems, ducks are farmed in a closed room in such a way to provide appropriate air conditioning and ventilation as is for chicken (Rodenburg et al., 2005).

Growth of the animals has a complicated structure and is influenced by genetic and environmental factors. These factors are species, sex, breed, care, and feeding (Saatci and Tilki, 2007). While growth is characterized by increase of body weight, development is characterized by changes in functions, structure, and shape of tissues and organs in the body. The effect of sex on growth in poultry becomes more apparent with age (Akcapınar and Ozbeyaz, 1999). Even though growth varies by species in waterfowls, it is generally more rapid in males than females (Pingel, 1990). Nutrient and mineral supply to birds, cost and type of feed, bird health, welfare, and environmental issues are important considerations for profitability and operation in poultry production (Darmani Kuhi et al., 2010). Growth curve models greatly help these considerations in poultry operation (Eleroglu et al., 2014). Some of these considerations are daily feed for growth and ideal cutting age, and these models are used as selection criteria. Lately, Gompertz and Logistic growth models

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have been extensively used in poultry production for growth (Narinc et al., 2010).

Duck farming is carried out under primitive conditions in the form of small family-owned businesses in most regions in Turkey (Testik, 1995). Numerous studies have been conducted on growth characteristics of Peking ducks in Turkey. However, there is no sufficient information about yield characteristics of native ducks as well as different raising systems for ducks in Turkey. There are several studies on different raising methods and fattening times only for Peking ducks (Bochno et al., 2005; Lacin and Aras, 2008; Erisir et al., 2009) and the number of studies on native ducks is limited.

The main objective of this study was to investigage live weight curves and body measurements of male and female native ducks raised in different raising systems. The secondary objective was to determine the predictive power of the Three-Parameter Logistic and Gompertz models for growth estimation in ducks.

Material and Methods

This research was carried out in a poultry facility in Kars, Turkey (40°34'34.6" N and 43°02'32.4" E). Duck eggs were supplied from a private farm and were hatched in an egg incubator. Hatched ducklings received a number on their wings and were divided into two groups after sex determination. A total of 120 ducklings, including 30 males and 30 females in cage system (CS) and 30 males and 30 females in deep litter floor (DLF), were used in the study. Ducks which died due to any reason were not included in the study. All ducks were farmed under the same conditions. In the deep litter floor, 8-10 cm thick wood chips were spread, and ducklings were placed as four per m^2. In the cage system, nine cages having dimensions of 1 × 2 × 0.85 m were used and ducklings were placed as 7-8 in each cage (European Commission, 2013). All day illumination was applied for the first week. After the first week, 16-h light and 8-h dark periods were applied. Temperature of duck house was set as 32-34 °C in the first week, then was gradually decreased by 3-5 °C every week, and reached 19-20 °C in the 4th week. All ducks received *ad libitum* feed containing 22% raw protein and 3000 kcal/kg metabolizable energy during the first five weeks. From five to eight weeks of age until the experiment was concluded, they received *ad libitum* feed containing 18% raw protein and 3100 kcal/kg metabolizable energy (NRC, 1994).

The ducks were weighed every two weeks on an empty stomach before feeding in the morning. Then, once their live weights were determined, their body values were measured. Their body values were not measured in the first week. The study was completed at the end of eight weeks. In the study, the bill length was measured as the distance between the tip of the bill and rear end of the beak, whereas the head length was measured as the distance between rear end of bill and condyle occipital by using a tape measure. Bill and head diameters and bill width were measured with a digital caliper. While neck length was measured as the distance between the first and last cervical vertebrae, body length was measured as the first lumbar vertebra and pygostyle. Tibia, fibula, and femur lengths were determined from left leg by using a tape measure. While chest depth was measured from distance between the first dorsal vertebra and sternum, chest width was measured as the distance between right and left glenoid cavity. A digital caliper was used to measure chest depth and width. Chest circumference was measured from point of *pectus* (posterior chest) by using a tape measure. Wing length was determined as the distance between the 3rd carpal bone and the *caput humeri* (Szabone Willin, 1997).

Variance analysis method was used in repeated measurements for time-dependent variance of live weight and body measurements. The two-way analysis of variance (Two-way ANOVA) was used to reveal the difference between raising systems and sexes affecting live weight and body measurements according to each week. The following growth curve models were fitted for the body weights according to raising system and sex:

Gompertz $Y = a*Exp(-Exp(b-c*X))$

Logistic $Y = a/(1+Exp(b-c*X))$

For each model, Y is the live weight at a particular age, X is age in weeks, a is the asymptotic weight or maximum growth response, b is a scale parameter (constant) related to initial weight, and c is the intrinsic growth rate. Estimation of model parameters was performed by using PASW packaged software (version 18.0).

Results

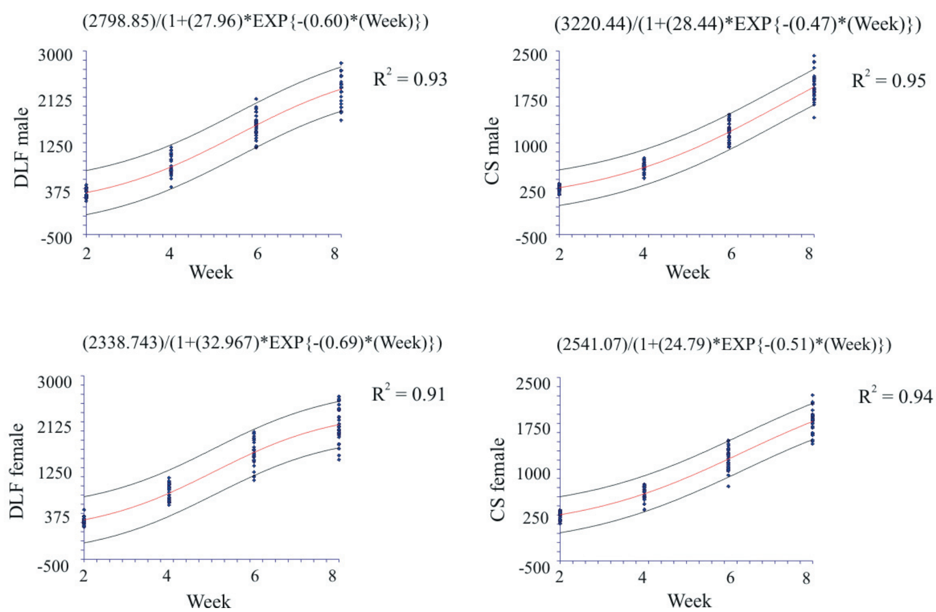
The coefficients of determination were between 0.91-0.95 in both models (Table 1). The highest value of coefficients of determination was observed in males farmed in CS (0.95) in both models, whereas the lowest value was observed in females farmed (0.91) in DLF (Figures 1 and 2). The lowest number of iterations was observed in Gompertz model.

Live weight and body measurements increased with increasing age in different raising systems (Figure 2).

Table 1 - Parameters of growth curve models for body weights of male and female ducks reared in different housing systems

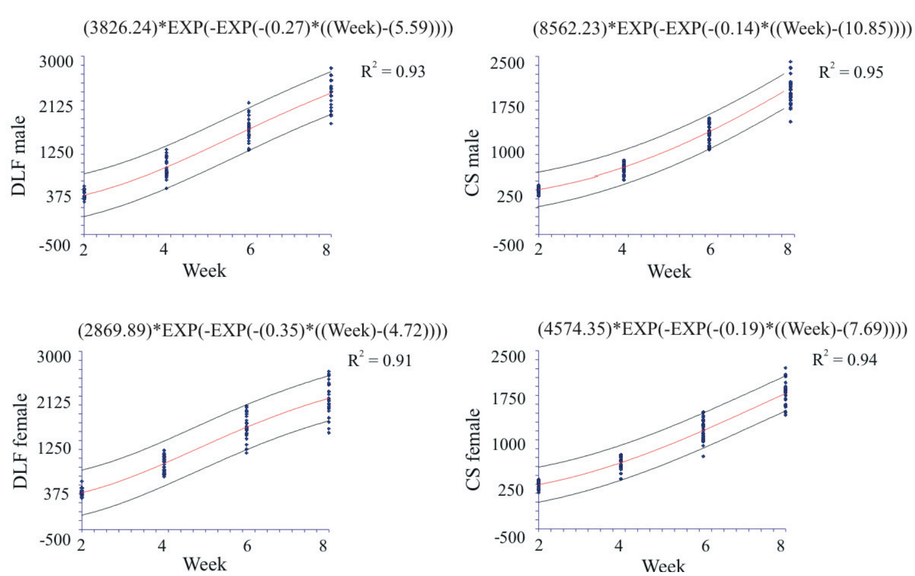
Model	Sex	Housing system	Number of iterations	Parameter estimation			
				A	B	C	R^2
Three-Parameter Logistic	Male	DLF	11	2798.85	27.96	0.60	0.93
		CS	13	3220.44	28.44	0.47	0.95
	Female	DLF	21	2338.74	32.97	0.69	0.91
		CS	12	2541.07	24.79	0.51	0.94
Gompertz	Male	DLF	6	3824.24	0.27	5.59	0.93
		CS	10	8562.23	0.14	10.85	0.95
	Female	DLF	4	2869.89	0.35	4.72	0.91
		CS	6	4574.35	0.19	7.69	0.94

CS - cage system; DLF - deep litter floor; R^2 - coefficient of determination.



CS - cage system; DLF - deep litter floor.

Figure 1 - Growth curves according to Logistic model for body weights of male and female ducks reared in different housing systems.



CS - cage system; DLF - deep litter floor.

Figure 2 - Growth curves according to Gompertz model for body weights for male and female ducks reared in different housing systems.

While ducks raised in DLF generally had higher values than those raised in CS in terms of live weight and body measurements, male ducks generally had higher values than female ducks (Figure 3). Interactions of time-raising system (P<0.001) and time-sex (P<0.01) in terms of live weight were statistically significant. Interactions of time-raising system, except for fibula diameter, were significant at various rates in terms of body measurements (P<0.001-P<0.05) (Figure 3). Interactions of time-sex were statistically insignificant in terms of all body measurements (P>0.05) (Figure 3). While live weights of 8 week-old male and female ducks raised in CS were 1911 and 1780 g, respectively, live weights of male and female ducks raised in DLF were 2276 and 2071 g, respectively. While the highest live weight gain of ducks raised in CS occurred between the 6th and 8th weeks, the highest live weight gain of ducks raised in DLF occurred between the 4th and 6th weeks.

Discussion

In this study, live weight values of ducks raised in DLF in the 4th, 6th, and 8th weeks were higher than those of ducks raised in CS. This difference might be associated with the fact that behaviors, such as flying, running, walking, wing flapping, etc., and welfare levels of ducks raised in DLF were better than those of ducks raised in CS, and accordingly, their stress level was lower. The effect of different raising systems in chickens was reported by Lay Jr. et al. (2011). The fact that ducks reached slaughtering weight in terms of live weight values at the end of the study indicates how important the effect of raising system is. In this study, live weight values of ducks raised in DLF and CS in the 2nd, 4th, 6th, and 8th weeks were lower than live weights of Peking ducks raised in DLF and CS reported by Sari et al. (2013). The most important reason for this difference was the breed factor. Live weights of ducks raised in CS in the 2nd, 4th, and 8th weeks in this study were higher than values in control group of native ducks raised in cage determined by Arslan et al. (2003). This difference was due to differences in origin, care, and feeding.

While sex had no effect on live weight in the first week, significant differences were found in the 8th week, and live weights of male ducks were higher than those of females. In this study, 4th-week live weight values of male and female ducks were lower than values reported by Isguzar et al. (2002) for different male and female local and Turkish Peking ducks; on the other hand, live weight values in the 8th week were higher than values reported by the same researchers. The live weight values in the 2nd, 4th, 6th, and 8th weeks determined in this study were higher than values reported by Ihuoma and Okata (2016) for Aylesbury ducks and by Kolluri et al. (2015) for native ducks reared under different raising systems. While live weight values of male ducks in the 8th week in this study were lower than the values reported by Ogah et al. (2011) in 15 week-old male Moscow ducks, live weight values of female ducks were higher than values reported by the same researcher for female ducks. These differences were mainly due to breed and differences in care and feeding.

Body measurements of ducks increased with increasing age. Generally, it was found that the effect of raising system on body measurements was significant, and body measurements of ducks raised in DLF were higher than those of ducks raised in CS. Even though body length and bill length of male and female ducks in the 2nd, 4th, 6th, and 8th weeks in this study were lower than values reported by Ihuoma and Okata (2016) for Aylesbury ducks, wing length and fibula length of male and female ducks in the 2nd, 6th, and 8th weeks were higher than values reported by the same researcher. Head length, bill length, bill diameter, neck length, body length, chest depth, chest width, tibia length, and fibula length values of male and female ducks in the 6th week in this study were lower than values reported by Onbasılar et al. (2011) with Peking ducks. This difference was caused by breed. It was determined that body length, chest circumference, and neck length of male and female ducks in the 8th week in this study were higher than values reported by Ogah et al. (2011) for 15 week-old Moscow ducks. Their femur lengths were lower than values reported by the same researcher, and fibula lengths were similar. Body length, femur length, chest circumference, and chest width of male and female ducks in this study were lower than values reported by Raji et al. (2009) for Moscow ducks, and fibula diameter and bill length were higher than values reported by the same researcher. The reason that results obtained in this study were different from other studies was associated with differences in breed, age, farming type, and care and feeding. Because no study has been conducted to determine the effect of different raising systems on body measurements of native ducks, a detailed comparison was not made.

According to results obtained in this study, live weight and body measurements of native ducks raised in DLF were better than those of ducks raised in CS. Generally, values of male ducks were higher than values of female ducks in terms of the examined characteristics.

Selvaggi et al. (2015) compared Logistic, Gompertz, and Richards growth curve models to find the most appropriate method for live weight data of chickens and

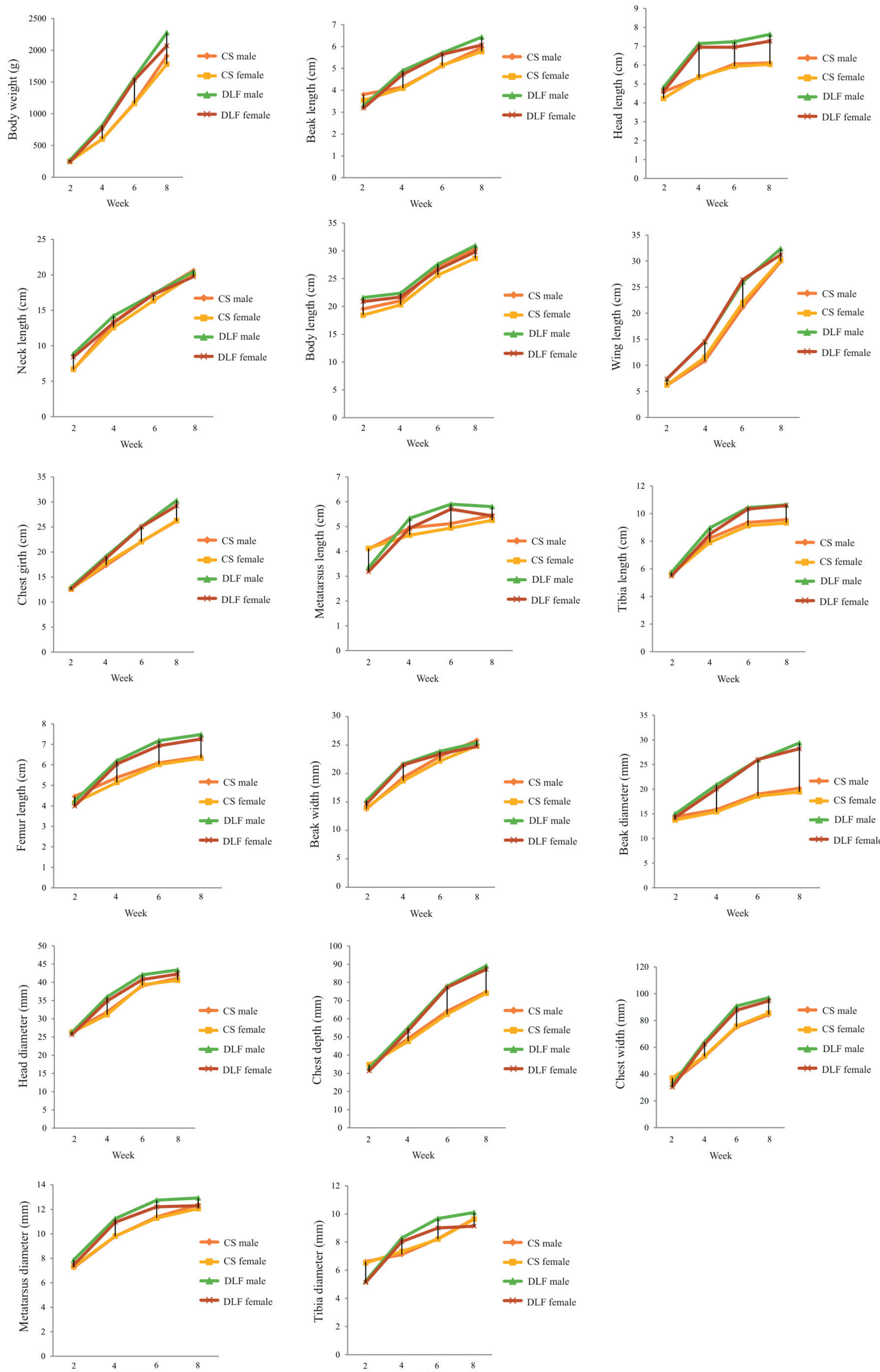


Figure 3 - Mean body weights and body measurements of male and female ducks of reared in different raising systems.

stated that the most suitable model is Gompertz. In another study, Zhao et al. (2015) compared the logistic, Gompertz, and Bertalanfy models in the growth of three chicken breeds and found that the Gompertz model showed less bias in practice.

Conclusions

Different raising models are used to observe the growth of birds in the poultry industry. When compared with cage system, deep litter floor is more appropriate for live weight of ducks. When two growth models are compared, Gompertz model is preffered to Three-Parameter Logistic model for having fewer iteration number, although the R^2 (coefficient of determination) and MSE (minimum square error) values are close to each other.

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