Analysis of growth curves of Guinea fowl (Numida meleagris) fed diets containing dry oregano (Origanum vulgare L.) in an organic system

H. Eleroğlu1, A. Yıldırım2, A. Canikli2, M. Duman3 and H. Bircan4
1Cumhuriyet University, Şarkışla Aşık Veysel Vocational High School, Şarkışla, Sivas, Turkey.
2Gaziosmanpaşa University, Agriculture Faculty, Department of Animal Science. Tokat, Turkey.
3Niğde Ömer Halisdemir University, Laboratory Assistant and Veterinary Health Department, Bor Vocational High School. Niğde, Turkey.
4Cumhuriyet University, Faculty of Economics and Administrator Sciences, Business Department. Sivas, Turkey.

Abstract

H. Eleroğlu, A. Yıldırım, A. Canikli, M. Duman, and H. Bircan. 2018. Analysis of growth curves of Guinea fowl (Numida meleagris) fed diets containing dry oregano (Origanum vulgare L.) in an organic system. Cien. Inv. Agr. 45(2): 99-108. In this study, 240 day-old guinea fowl (Numida meleagris) keets were utilized. They were divided into four treatment groups each containing 20 chicks and were randomly distributed into 12 mobile coops placed in a 100-m² grazing area. Guinea fowl chicks were randomly allocated to 4 treatment diets containing 0%, 5%, 10%, and 15% dry oregano leaf (DOL) supplements. Nonlinear Gompertz and logistic growth models were used to estimate the mean age-body weight. The growth curve parameters for these models and the following characteristics for fowl were estimated: β₀, the asymptotic weight parameter; β₁, the scaling parameter; β₂, the instantaneous per week growth rate; weight at age of inflection point (WIP); maximum weight gain at inflection point (MWG); and age at the inflection point (AIP). The goodness of fit (GF) for the models was assessed using the following variables: coefficients of determination ($r^2$), mean square error (MSE), adjusted determination coefficient (ADR²), Akaike’s information criteria (AIC), chi-square test ($Chi.Sq^2$) and residual standard deviation (RSD). The different nonlinear function results of the individual data indicated that supplementation of diets with DOL had no significant effects on growth curve parameters when compared with the control diet. Greater correlation values were estimated among $\beta_0$, $\beta_1$, $\beta_2$, WIP, MWG and AIP in the Gompertz equation, and similar results were estimated in the logistic equation, but there was no significant correlation between $\beta_2$-$\beta_1$ and $\beta_2$-MWG. According to the results obtained from the GF, high $r^2$ and ADR² were estimated in Gompertz and logistic equations (above 0.96).

Key words: Growth models, growth parameters, Guinea fowl, oregano levels, organic production

Introduction

Genetic and environmental conditions affect growth, which is known as the process of a bird gaining body weight with age until it reaches maturity (Porter et al., 2010). Growth measurements for birds and control of the environmental conditions that affect their body weight gain are common practices in the poultry industry because of their economic importance (Aggrey, 2009). In recent years, growth functions have become
more prevalent for monitoring and characterizing growth and to estimate the different periods of growth such as the WIP, MWG, AIP and age of sexual maturity (Eleroğlu et al., 2014). These characteristic values are used to explain body weight gains and estimate the expected body weight at a particular age. Moreover, mathematical model results for heritability are high and widely used in research focused on selection, environmental changes (Goto et al., 2010) and prediction of daily feed requirements for several ages (Pomar et al., 2009). Additionally, it is feasible to use mathematical models to determine better management practices to increase animal production (Selvaggi et al., 2015). Growth models will allow the determination of optimal management application and productivity of guinea fowl farms (Nahashon et al., 2006a). The growth curves were applied because of their relevance when diets contain various types of additives (Abbas et al., 2014). Additives may not limit the final weight, but they may influence the shape of growth (Fatten, 2015).

There are many growth functions used to describe changes in body weight. Because these growth functions have several characteristics and different mathematical limitations, it is important to be careful when choosing the mathematical model that best describes the growth type (Norris et al., 2007).

Gompertz, Logistic, Von Bertalanffy, Richards and Brody mathematical models are widely used to describe poultry growth curves (Liu et al., 2011; Eleroğlu et al., 2014) and have been modeled for turkeys (Meleagris gallopavo), ostriches (Struthio camelus) (Brand et al., 2012), quails (Coturnix coturnix japonica) (Raji et al., 2014), guinea fowl (Numida meleagris) (Nahashon et al., 2006a, 2006b, 2010) and chickens (Gallus gallus domesticus) (Marcato et al., 2008; Şekeroğlu et al., 2013; Al-Samarai, 2015).

As reported by Eleroğlu et al. (2016), guinea fowl (Numida meleagris) chicks were randomly allocated to 4 treatment diets containing a 0%, 5%, 10%, or 15% dry oregano (Origanum vulgare L.) supplement. During this experiment, all basal feed and water were provided ad libitum for all keets. Nonlinear Gompertz and logistic growth models are widely used to estimate the relationship between mean age and body weight (Eleroğlu et al., 2014). The mathematical equations for these models and the characteristics of growth curves for poultry WIP, MWG and AIP are presented in Table 1 (Narinc et al., 2010; Eleroğlu et al., 2014).
For each model, $\beta_0$ was the asymptotic (mature) weight parameter, $\beta_1$ was the scaling parameter (scale parameter related to initial weight), and $\beta_2$ was the instantaneous per week growth rate (Yang et al., 2006; Raji et al., 2014; Eleroğlu et al., 2014).

The calculation of GF has different methods to compare the performances of the non-linear models. In this study, GF for the models was assessed using $r^2$, MSE, ADR$^2$, AIC, Chi.Sq$^2$ and RSD. The equations for GF are given in Table 2.

Microsoft Excel 10.0 was utilized for the Chi.Sq$^2$ computation. The other GF criteria were calculated using ANOVA tables, and calculations were carried out with the nonlinear regression option in SPSS 15.0 (Inc. Chicago IL, USA). The Levenberg–Marquart estimation method was used for two models within the statistical software package program (Marquardt, 1963).

The WIP parameter from the Gompertz model was greater (394.91-485.76) when compared with the logistic models (294.98-339.67) and was affected by the high $\beta_0$ values. Although there was no difference between MWG values from the application, the values obtained from the logistic model (84.06-96.05) were greater than the values obtained from the Gompertz model (53.17-60.41).

### Results

Table 3 shows the estimated standard error of the mean and the P value for Gompertz and logistic model growth parameters for Guinea fowl (*Numida meleagris*) genotypes examined in an organic system. The different nonlinear function results of the individual data indicate that supplementation of diets with DOL had no significant effects on growth curve parameters ($\beta_0$, $\beta_1$, $\beta_2$, AIP, WIP, MWG, and $r^2$) when compared with the control diet ($P>0.05$).

The estimated $\beta_0$ parameter was greater for the Gompertz model (1073.37 to 1320.31 g) when compared with the logistic equations (801.77 to 923.23 g). The values for the $\beta_1$ parameter in the Gompertz model were lower (3.52, 3.24, 3.30, 3.21 for the supplementation of diets with DOL at levels 0%, 5%, 10%, and 15%, respectively) when compared with the respective values for the logistic model (17.16, 13.28, 13.83, 13.07, respectively). The $\beta_2$ parameter was lower in the Gompertz model (0.13 to 0.14) when compared with that in the logistic model (0.27-0.29). The range in terms for AIP obtained from the Gompertz (8.62-9.94) and logistic (8.92-9.74) models were similar.

### Table 1. The mathematical equations for the models and characteristics of growth curves for poultry

<table>
<thead>
<tr>
<th></th>
<th>Gompertz</th>
<th>Logistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corresponding weight at time (W)</td>
<td>$\beta_0 \exp(-\beta_1 \exp(-\beta_2 t))$</td>
<td>$\beta_0 (1+\beta_1 \exp(-\beta_2 t))^{-1}$</td>
</tr>
<tr>
<td>Age at the inflection point (AIP)</td>
<td>$(\ln \beta_1) / \beta_2$</td>
<td>$(\ln \beta_1) / \beta_2$</td>
</tr>
<tr>
<td>Weight at age of inflection point (WIP)</td>
<td>$\beta_0 / e$</td>
<td>$\beta_0 / 2$</td>
</tr>
<tr>
<td>Maximum weight gain at inflection point (MWG)</td>
<td>$\beta_2 \text{WIP}$</td>
<td>$\beta_2 \text{WIP}/2$</td>
</tr>
</tbody>
</table>

### Table 2. The criteria of the GF test in the selection of Gompertz and logistic models

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Abbrev.</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-square test</td>
<td>$\chi^2$</td>
<td>$\sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i}$</td>
</tr>
<tr>
<td>Coefficient of determination</td>
<td>$r^2$</td>
<td>$1-(SE/TS)$</td>
</tr>
<tr>
<td>Adjusted determination coefficient</td>
<td>$AR^2$</td>
<td>$r^2-(k-1-n-k)(1-r^2)$</td>
</tr>
<tr>
<td>Mean square error</td>
<td>MSE</td>
<td>$SE/(n-k)$</td>
</tr>
<tr>
<td>Akaike’s information criteria</td>
<td>AIC</td>
<td>$n \ln (SE/n)+2k$</td>
</tr>
<tr>
<td>Residual standard deviation</td>
<td>RSD</td>
<td>$(SE)^{1/2}(n-k)^{1/2}$</td>
</tr>
</tbody>
</table>

$O_i=$measured value; $E_i=$estimated value; SE=sum of squared errors; TS=total sum of squares; $n=$number of observations; $k=$number of parameters.
The average observed and estimated growth curves for body weight obtained from the application of mathematical equations for the Gompertz and Logistic models are represented in Figures 1, 2 and 3. Bodyweight increased with age, and the average AIP was between 9.11 and 9.22 wks when the average MWG (57.20 and 90.20 g wk\(^{-1}\)) in the Gompertz and logistic models was attained. WIP at this age averaged 440.30–315.22 g for each Gompertz and Logistic equation. After AIP, the growth rate fell and was near zero at maturity. The shapes of the estimated growth curves were distinctive “S” sigmoid.

The correlation coefficients for both models were higher and seem similar in structure (Table 4). Higher correlation coefficients were estimated among \(\beta_0\), \(\beta_1\), \(\beta_2\), AIP, WIP and MWG \((P<0.01)\) in the Gompertz model. Although comparable results were calculated in the logistic model, there were no significant correlations between \(\beta_2\)-\(\beta_1\) and \(\beta_2\)-MWG. The correlations were found to be negative among \(\beta_1\), and \(\beta_0\), \(\beta_1\), AIP, WIP and MWG parameters \((P<0.01)\) in the Gompertz model. Although comparable negative results were estimated for \(\beta_2\) \((P<0.01)\) in the logistic model, there was no significant correlation between \(\beta_2\)

### Table 3. Estimated mean of standard error and P value for Gompertz and logistic model growth parameters in guinea fowl

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Origanum vulgare L. leaf (DOL) in diet (%)</th>
<th>Average</th>
<th>SEM*</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Gompertz model</td>
<td>β₀</td>
<td>1320.31</td>
<td>1073.37</td>
<td>1174.70</td>
</tr>
<tr>
<td></td>
<td>β₁</td>
<td>3.52</td>
<td>3.24</td>
<td>3.30</td>
</tr>
<tr>
<td></td>
<td>β₂</td>
<td>0.13</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>AIP</td>
<td>9.94</td>
<td>8.62</td>
<td>8.74</td>
</tr>
<tr>
<td></td>
<td>WIP</td>
<td>485.76</td>
<td>394.91</td>
<td>432.19</td>
</tr>
<tr>
<td></td>
<td>MWG</td>
<td>60.41</td>
<td>53.17</td>
<td>59.54</td>
</tr>
<tr>
<td></td>
<td>r²</td>
<td>0.97</td>
<td>0.96</td>
<td>0.96</td>
</tr>
<tr>
<td>Logistic model</td>
<td>β₀</td>
<td>923.23</td>
<td>801.77</td>
<td>891.40</td>
</tr>
<tr>
<td></td>
<td>β₁</td>
<td>17.16</td>
<td>13.28</td>
<td>13.83</td>
</tr>
<tr>
<td></td>
<td>β₂</td>
<td>0.28</td>
<td>0.29</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>AIP</td>
<td>9.74</td>
<td>8.92</td>
<td>9.05</td>
</tr>
<tr>
<td></td>
<td>WIP</td>
<td>339.67</td>
<td>294.98</td>
<td>327.96</td>
</tr>
<tr>
<td></td>
<td>MWG</td>
<td>96.05</td>
<td>84.06</td>
<td>94.65</td>
</tr>
<tr>
<td></td>
<td>r²</td>
<td>0.97</td>
<td>0.97</td>
<td>0.97</td>
</tr>
</tbody>
</table>

*SEM: Standard error of the mean
and $\beta_1$. High positive relationships among $\beta_0$ and $\beta_1$, AIP, WIP and MWG were found ($P<0.01$) in the two models.

The Gompertz and logistic GF results for DOL levels are presented in Table 5. According to the estimated results, the coefficient of determination ($r^2$) and adjusted determination coefficient ($AR^2$) were found to be greater than 0.94 in both growth models for DOL levels. The highest average value of $r^2$ (0.965) was calculated from the logistic growth curve model. Considering the mean values, fitting the growth functions occurred the lower MSE (2763.51, 2817.46); AIC (152.46, 153.20) and RSD (49.21, 50.02) values occurred in Gompertz and logistic growth curve models, respectively. A chi-square test was applied and estimated individual values for the two models to compare their fitness (Table 5). There were no

![Figure 3. Average observed body weight and estimation of growth curves using the Gompertz and logistic models for guinea fowl in an organic system]

Table 4. Estimate correlations of $\beta_0$, $\beta_1$, $\beta_2$ WIP, MWG, AIP from Gompertz and logistic nonlinear growth curve models

<table>
<thead>
<tr>
<th>Items</th>
<th>Gompertz Model</th>
<th>Logistic Model</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\beta_0^1$</td>
<td>$\beta_1^2$</td>
<td>$\beta_2^3$</td>
<td>AIP$^4$</td>
<td>WIP$^5$</td>
<td>MWG$^6$</td>
<td>$\beta_0^1$</td>
<td>$\beta_1^2$</td>
</tr>
<tr>
<td>$\beta_0$</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>0.739**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.678**</td>
<td></td>
</tr>
<tr>
<td>$\beta_2$</td>
<td>-0.724**</td>
<td>-0.446**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.374**</td>
<td></td>
</tr>
<tr>
<td>AIP$^4$</td>
<td>0.915**</td>
<td>0.698**</td>
<td>-0.863**</td>
<td>1</td>
<td></td>
<td></td>
<td>0.789**</td>
<td></td>
</tr>
<tr>
<td>WIP$^5$</td>
<td>&gt;0.99**</td>
<td>0.739**</td>
<td>-0.724**</td>
<td>0.915**</td>
<td>1</td>
<td></td>
<td>0.678**</td>
<td></td>
</tr>
<tr>
<td>MWG$^6$</td>
<td>0.790**</td>
<td>0.807**</td>
<td>-0.310**</td>
<td>0.540**</td>
<td>0.790**</td>
<td>1</td>
<td>0.798**</td>
<td></td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed).

Table 5. GF criteria results for $\beta_0$, $\beta_1$, $\beta_2$ WIP, MWG, AIP from Gompertz and logistic nonlinear growth curve models

<table>
<thead>
<tr>
<th>Items</th>
<th>Gompertz Model</th>
<th>Logistic Model</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>DOL (%)$^1$</td>
<td>&gt;0.05</td>
<td>$r^2$</td>
<td>$AR^2$</td>
<td>MSE</td>
<td>AIC</td>
<td>RSD</td>
<td></td>
</tr>
<tr>
<td>Gompertz</td>
<td>0</td>
<td>100</td>
<td>0.97</td>
<td>0.97</td>
<td>2550.51</td>
<td>152.62</td>
<td>48.61</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>100</td>
<td>0.96</td>
<td>0.97</td>
<td>1976.53</td>
<td>149.00</td>
<td>43.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>100</td>
<td>0.96</td>
<td>0.97</td>
<td>2808.85</td>
<td>154.70</td>
<td>51.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>100</td>
<td>0.94</td>
<td>0.95</td>
<td>3718.14</td>
<td>153.50</td>
<td>53.46</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>100</td>
<td>0.958</td>
<td>0.965</td>
<td>2763.51</td>
<td>152.46</td>
<td>49.21</td>
<td>50.02</td>
<td></td>
</tr>
<tr>
<td>Logistic</td>
<td>0</td>
<td>100</td>
<td>0.97</td>
<td>0.97</td>
<td>2491.57</td>
<td>152.82</td>
<td>48.51</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>100</td>
<td>0.97</td>
<td>0.97</td>
<td>2055.17</td>
<td>149.86</td>
<td>44.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>100</td>
<td>0.97</td>
<td>0.97</td>
<td>2875.85</td>
<td>155.46</td>
<td>52.49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>100</td>
<td>0.95</td>
<td>0.95</td>
<td>3847.25</td>
<td>154.64</td>
<td>54.89</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>100</td>
<td>0.965</td>
<td>0.965</td>
<td>2817.46</td>
<td>153.20</td>
<td>50.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^1$DOL: Dry oregano leaf
differences between DOL levels, and the Chi²₀.₀₅ % parameter values for both models were estimated as higher (100%).

Discussion

No significant differences were detected between the Gompertz and logistic growth curve values for guinea fowl fed diets containing various DOL levels in an organic system (P>0.05). For this reason, average or range values were used for discussion.

The shapes of the growth curves obtained from the Gompertz and logistic nonlinear models were typically sigmoid (Figures 1, 2 and 3). According to the literature for poultry and other animals, the age-body weight and volume of the body and most organs are measured from conception to senescence; the curves of the collected data show a flattened sigmoid curve called “S” shape or nonlinear S-shaped function (Swatland, 1994; Arseniy, 2006). However, the growth curves for meat animals raised under intensive production, free range and organic systems may vary as relatively flat or steep slopes. When the data were obtained from very young animals, the growth curve may become apparent, and the growth rate was nearly stable during the intensive growing period (Swatland, 1994). Initially in the sigmoid curve, the rate of growth was low but increased with advanced age. The growth attained a maximum, it complied with to AIP, and then, it slowly declined to zero once the animals achieved their β₀ (Michael, 1999; Arseniy, 2006). In this research and similar conditions in other studies, the Gompertz and logistic growth curves for guinea fowl (Nahashon et al., 2006b) or slow-growing broiler-raised guinea fowl in an organic system at 16 wks (Eleroğlu et al., 2014) were relatively flat compared with growth curves for guinea fowl raised in commercial conditions at 8 wks (Nahashon et al., 2006a, 2010).

Table 3 shows that the average β₀ parameter of 868.29 g estimated by the logistic model was lower than the β₀ parameter of 1196.74 g obtained by the Gompertz model. Although the estimated β₀ values of both models were lower than the results from Nahashon et al. (2006b), the β₀ parameter obtained from the Gompertz model was greater than that obtained by the logistic model, which is consistent with the literature (Nahashon et al., 2006a, 2006b; Narinc et al., 2010; Miguel et al., 2012; Eleroğlu et al., 2014). Based on the average value of β₀, the growth pattern of the guinea fowl broiler was closer to the Gompertz than the logistic model.

The logistic model showed a greater predicted β₁ (17.16 g) for the guinea fowl when compared with the Gompertz model (3.52 g). Similar observations were reported previously for guinea fowl (Nahashon et al., 2006a) and slow–growing chicken genotypes raised in an organic system (Eleroğlu et al., 2014).

The β₂ was also lower (0.14) for the Gompertz model than the logistic model (0.28); similar results were reported by Yang et al. (2006), Nahashon et al. (2006a, 2006b), Miguel et al. (2012), Beiki et al. (2013) and Eleroğlu et al. (2014). The higher β₂ value obtained from the logistic model may further explain the lower β₀ predicted by the logistic model (Nahashon et al., 2006a).

The AIP values were similar for the Gompertz and logistic models (from 9.11 to 9.22 wk of age; Table 3, Figures 1, 2 and 3) but were found to be higher for each model in several other studies (Santos et al., 2005; Nahashon et al., 2006a,b, 2010). The range of AIP values for each model was estimated to be 5.72 to 5.94 wk. of age for the meat-type variety of French guinea fowl when conventionally reared for 9 wks of fattening period (Nahashon et al., 2006a, 2010) and were determined to be between 6.5 to 8.2 wk. of age for the pearl gray guinea fowl during the slow-growing 22 wks of fattening period (Nahashon et al., 2006b). The range of AIP was high (6.28 and 7.08 wk. of age) in the slow-growing broilers (Santos et al., 2005), whereas the corresponding range was low (4.58
and 5.78 wk. of age) in conventionally reared fast-
growing broilers (Marcato et al., 2008). On the
other hand, in this study, the point of inflection
for guinea fowl was close to pure-bred chickens
of unselected populations, which ranged from
9.1 to 11.64 wk. of age (Knizetova et al., 1985),
and over predicted observations (11.54 to 13.99)
were reported for the slow-growing chicken
genotypes raised in an organic system (Eleroğlu
et al., 2014). According to the results, the AIP
value is influenced by genotype, rearing system
and fattening period.

The WIP, $\beta_1$, and $\beta_2$ values can vary depending on
the ratio of the nutrient content. Nahashon et al.
(2010) observed that WIP values were significantly
lower in French guinea broilers fed the 21% CP
diet (738 g) than those fed the 23% (780 g) and
25% CP diets (789 g) during the conventionally
reared 9 wks of the fattening period. In contrast,
in this study, according to the findings Nahashon
et al. (2010), low average WIP at this age was
estimated to be 440.30 – 319.46 g for the Gompertz
and logistic models in an organic system
during 16 wks of fattening period. The observed
differences are explained by the different rearing
systems, fattening period and genetic origins of
the flocks used.

The $\beta_0$ slowly increased with age until the AIP
averaged 9.11 and 9.22 wks, at which time the
MWG average was 57.20 and 90.20 g wk$^{-1}$
in the Gompertz and logistic models, respectively.
Beyond this age, MWG declined rapidly and
approached zero at maturity.

The $\beta_0$, $\beta_1$, and $\beta_2$ values for guinea fowl predicted
by the Gompertz and logistic models for the
supplementation of diets with DOL at levels
of 0%, 5%, 10%, and 15% were compatible
with observed body weight values (Figures
1, 2 and 3).

The two models fit the growth curves for guinea
fowl in an organic system very well, and the fit-
ing degrees $r^2$ were all above 0.95; however, the
logistic model was the best performing model
(0.965%). The GF for the Gompertz and logistic
growth curve models in this study was found to be
concordant with various studies (Norris et
al., 2007; Narinc et al., 2010). Under optimum
growing conditions, this maturation rate showed
up in the logistic equation, which is a sigmoidal
growth curve that describes broiler growth
with amazing accuracy (Eleroğlu et al., 2014).
This result implies that the growth pattern of
guinea fowl was closer to the logistic than the
Gompertz model. Although these results are
consistent with previous results by Eleroğlu
et al. (2014), the results are not compatible with results of Nahashon et al. (2006b) because of
the differences in the duration of fattening and
breeding systems.

In the current study, the growth function esti-
mates of $\beta_0$, $\beta_1$, $\beta_2$, AIP, IWP, MWG and $r^2$ for the
guinea fowl fed diets containing DOL at levels
0%, 5%, 10%, and 15%, were 1196.74, 3.32,
0.14, 9.11, 440.30, 57.20 and 0.96, respectively,
in the Gompertz model and 868.29, 14.34, 0.28,
9.22, 319.46, 90.20 and 0.97, respectively, in the
logistic models. These means were not signifi-
cant in the Gompertz nor the logistic models
($P>0.05$). Based on the Gompertz and logistic
growth model estimates, feeding with DOL at
a level of 15% can be recommended as safe and
as meat flavor or growth for the guinea fowl in
an organic system.

The value of AIP varied depending on the rear-
ing systems and genotypes. Fast-growing broiler
genotypes are often used in conventional rear-
ing systems, and estimated lower AIP values
and growth patterns for birds were closer to the
Gompertz than the logistic model.

Acknowledgements

This study was supported by the Research
Fund of Cumhuriyet University (Project No:
ENF–006).
Resumen

H. Eleroğlu, A. Yıldırım, A. Canikli, M. Duman, y H. Bircan. 2018. Análisis de curvas de crecimiento de aves de Guinea (Numidea meleagris) con dietas que contienen orégano seco (Origanum vulgare L.) en un sistema orgánico. Cien. Inv. Agr. 45(2): 99-108. En este estudio, se utilizaron las gallinas de Guinea (Numidea meleagris) de 240 días de vida. Se dividieron en cuatro grupos de tratamiento cada uno con 20 pollitos y fueron distribuidos al azar en 12 gallineros móviles colocadas en todos y cada uno de los 100 m2 de área de pastoreo. Gallinas de Guinea fueron asignadas al azar a 4 tratamientos (dietas) que contengan 0%, 5%, 10% y 15% de suplemento de hojas de orégano seco (DOL). Modelos no lineales de Gompertz y modelos logísticos fueron utilizados para estimar la edad media-peso vivo. El parámetro de curva de crecimiento de estos modelos y sus características para la gallina β0 es el parámetro de peso asintótico, β1 es el parámetro de escala, β2 es la tasa de crecimiento instantáneo por semana, el peso a la edad del punto de inflexión (WIP), el aumento de peso máximo en el punto de inflexión (MWG), la edad en el punto de inflexión (AIP). La bondad de ajuste (GF) de los modelos evaluados usando Coeficientes de Determinación (r2), El error cuadrático medio (MSE), el coeficiente de determinación ajustado (ADR2), los criterios de información de Akaike (AIC), la prueba de Pearson (ChiSq2) y la desviación estándar residual (RSD). Los diferentes resultados de las funciones no lineales de los datos individuales indicaron que la suplementación de dietas con DOL no tuvo efectos significativos en los parámetros de la curva de crecimiento en comparación con la dieta de control. Se estimaron valores de correlación más altos entre β0, β1, β2, WIP, MWG y AIP en la ecuación de Gompertz y un resultado similar estimado en la ecuación logística, pero no hay correlación significativa entre β2-β1 y β2-MWG. De acuerdo con los resultados obtenidos de GF, r2 alta y ADR2 se estimaron en la ecuación de Gompertz y logística por encima de 0,96.

Palabras clave: Gallina de Guinea, modelos de crecimiento, niveles de orégano, parámetros de crecimiento, producción orgánica.

Referencias


ing densities by gompertz model. The Journal of the Faculty of Veterinary Medicine, Kafkas University 19:669–672.

