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GROWTH EVALUATION OF TURKEY HEAVY HYBRID BY MEANS OF ASYMMETRIC S-FUNCTION

Z. Škrtić, Gordana Kralik, Zlata Gajčević

Original scientific paper

SUMMARY

The research into growth characteristics of turkey hybrid was carried out on 60 one-day-old turkeys (30 toms and 30 hens) of Nicholas 700 provenience. The research lasted for 19 weeks. Each turkey was marked with a leg ring. During the experiment, turkeys were fed commercial mixtures. Evaluation of the inflection point and of separate growth phases was obtained by means of asymmetric S-function (Kralik and Scitovski,

$$1993): f(t) = \frac{A}{(1 + be^{-ct})^{1/\gamma}},$$

$$t_B = \frac{i}{c\gamma} \ln \frac{2b}{\gamma(\gamma + 3) + \gamma\sqrt{(\gamma + 1)(\gamma + 5)}}, \quad t_C = \frac{i}{c\gamma} \ln \frac{2b}{\gamma(\gamma + 3) - \gamma\sqrt{(\gamma + 1)(\gamma + 5)}}$$

End weight of turkey toms was higher than the one of hens by 34.63% (14811±906 g : 11005±993 g). Differences in final weights between sexes, as well as in weights over the whole fattening period were statistically highly significant (P<0.001). Average absolute and relative gains (gain rates) of toms in comparison to hens were 776 g and 12.45%, and 567 g and 12.11%, respectively.

By the parameters of asymmetric S-function, intensification of progressive growth phase in turkey toms started after the 5th week, and in turkey hens it was prolonged for several days. Determined biological maximum in toms was 17.966 kg, and in hens 12.889 kg. Intensive growth of hens lasted up to the beginning of the 15th week, while toms grew intensively up to the end of the 15th week. Positions of the inflection point in hens were determined at the beginning of the 10th week, and in toms in the middle of that week.

Key-words: turkeys, absolute and relative gains, asymmetric S-function

INTRODUCTION

Growth as a basic function in production of animals refers to continuous weight gain. At a cellular level, it refers to proliferation due to cell division, followed by volume increase (hypertrophy). development of muscles refers to cell proliferation, followed by fusion and hypertrophy (Hurwitz and Talpaz, 1997).

Complex growth control was thrived to be described mathematically in form of biological growth models, through explaining principals of growth (von Bertalanffy, 1957) and creating models for their description (Zeger and Harlow, 1987).

Description of growth curve is a basis of each model, aiming at evaluation of biological and economic parameters in production of turkeys. Growth curve used for description of weight is usually of sigmoid shape, marked by a weak gain at the beginning, acceleration up to a certain age (inflection point), and followed by weaker gain as the weight reaches its maximum. In order to explain growth, there were several equations in use over the last 200 years (Zeger and Harlow, 1987), of which the Gompertz equation dated from 1825 is considered the most appropriate for presentation of growth curve in chickens (Tzeng and Becker, 1981; Talpaz et al., 1987). The Gompertz equation is applicable in many scientific areas, for example, in medicine for description of tumor growth, in biology for description of growth of organisms, in ecology, marketing, etc. (Jukić et al., 2003).

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The aim of this research was to determine growth characteristics of turkey toms and hens of Nicholas 700 provenience by applying specific mathematical model.

MATERIAL AND METHODS

The research into growth characteristics of turkey hybrid was carried out on 60 one-day-old turkeys (30 toms and 30 hens) of Nicholas 700 provenience. It lasted for 19 weeks. Each turkey was marked with a leg ring. During the experiment, turkeys were fed commercial mixtures. Their weight was controlled every week, on the basis of which data of the average weekly gain and gain rates for each group, as well as for each sex were calculated.

Weekly gain rates were calculated by means of the following mathematical formulas: $SP_i = (y_i - y_{i-1}) / y_{i-1}$ where: $i = 1 \dots 19$ week, y_i = weight of turkeys at the end of i week. Average gain rates for each turkey group were obtained by means of exponential function $f(x) = be^{cx}$, $(b, c) \in R^2$. Evaluation of the inflection point and each growth phase was obtained by means of asymmetric S-function (Kralik and Scitovski, 1993):

$$f(t) = \frac{A}{(1 + be^{-ct})^{1/\gamma}}$$

$$t_B = \frac{i}{c\gamma} \ln \frac{2b}{\gamma(\gamma + 3) + \gamma\sqrt{(\gamma + 1)(\gamma + 5)}}, \quad t_C = \frac{i}{c\gamma} \ln \frac{2b}{\gamma(\gamma + 3) - \gamma\sqrt{(\gamma + 1)(\gamma + 5)}}$$

Asymmetric S-function with one inflection point was strictly growing within the whole definition area. Parameters of asymmetric S-function b and c were determined on the basis of experimental data by applying the least squares method, where B marks the maximum point in the area of intensive growth (the area of convexity), and C represents the minimum point in the area of degressive growth (the area of concavity). The interval $t \leq t_B$ represents the phase of growth formation, the interval $t_B \leq t \leq t_C$ refers to the phase of intensive growth, and the interval $t \geq t_C$ marks the phase of growth deceleration. Research results were processed by the Statistica for Windows v.7.1 software (StatSoft, Inc., 2005). Statistical significance of differences between turkey sexes was determined by the t-test.

RESULTS AND DISCUSSION

Weights and weight gains of turkey toms and hens of Nicholas 700 provenience were presented in the Table 1. Lehmann et al. (1996) reported that turkeys in their experiment weighed from 17.81 to 18.45 kg in the 20th week of fattening.

Table 1. Live weights and weight gains of turkey toms and hens of Nicholas 700 provenience

Age (week)	Weight of toms, g	Weight of hens, g	Stat. ^a significance	Weight gain of toms, g	Weight gain of hens, g	Stat. ^a significance
1 st day	71±7	67±7	*	-	-	-
1	159±20	134±21	***	88±16	67±17	***
2	322±36	279±40	***	163±24	145±23	**
3	577±65	498±57	***	255±36	219±32	***
4	979±98	837±77	***	402±48	339±49	***
5	1582±156	1321±136	***	603±77	484±86	***
6	2338±236	1859±194	***	756±98	538±155	***
7	3299±315	2619±284	***	960±127	760±159	***
8	4364±428	3406±411	***	1066±167	788±165	***
9	5307±504	4110±533	***	942±194	704±258	***
10	6220±556	4813±692	***	913±237	703±246	**
11	7540±555	5844±808	***	1321±205	1031±248	***

12	8725±600	6747±823	***	1185±264	903±319	***
13	10002±671	7732±985	***	1277±306	984±319	***
14	11247±708	8618±1028	***	1245±276	887±263	***
15	12160±813	9258±1106	***	913±326	640±187	***
16	13035±938	9934±1085	***	874±323	675±187	**
17	13796±872	10460±1066	***	761±351	526±177	**
18	14490±892	10808±1028	***	695±360	348±323	**
19	14811±906	11005±993	***	320±470	197±331	n.s.

^a n.s *P>0.05, ** P<0.01, *** P<0.001

According to Noble et al. (1996), weights of turkey toms in specific fattening periods, i.e. in the 4th, 8th, 12th and 17th week were 1.07, 3.84, 8.62 and 14.19 kg, respectively (from 13.55 to 14.61 kg). In the research of Brenoe and Kolstad (2000), turkey toms in the 17th week of fattening weighed 13.06 kg, and hens 9.57 kg, while the weights of toms at the end of the 18th week of fattening in the research of Kidd et al. (1997) were from 11.68 to 12.76 kg. Ferket (2003) stated that the average weight of turkey toms in the USA at the end of the 18th fattening week was 15.13 kg, while hens weighed on the average 6.93 kg at the end of 14th week.

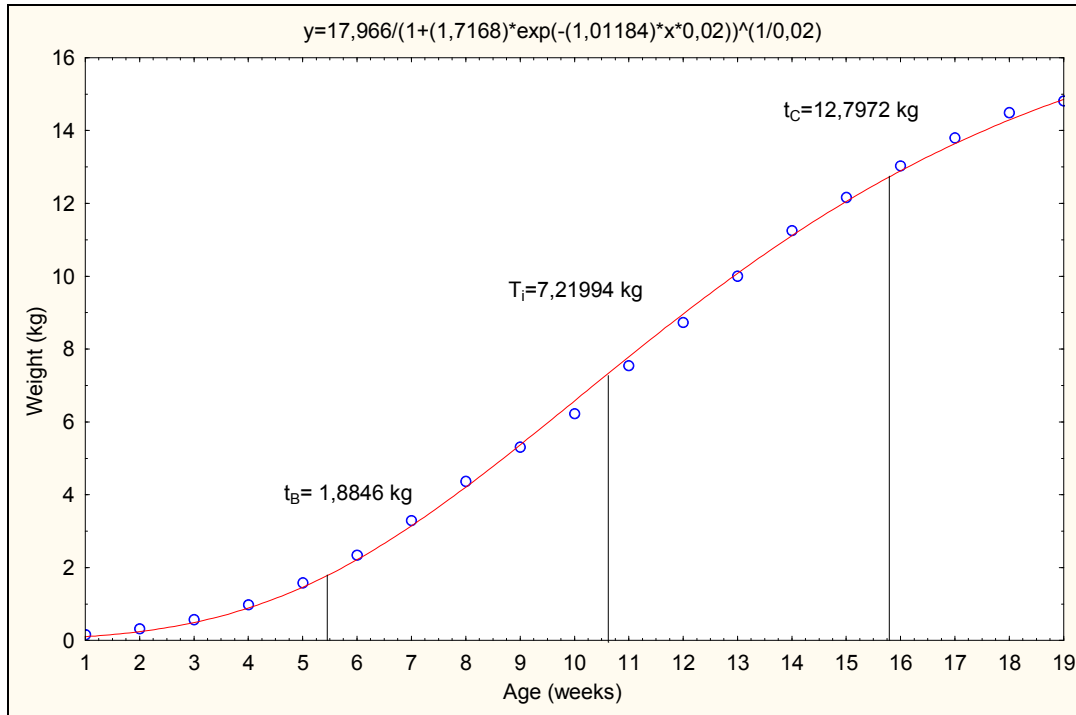
Table 2. Growth rates of turkey toms and hens of Nicholas 700 provenience

Age (week)	Growth rate of toms	Growth rate of hens
1	1.24	1.01
2	1.02	1.09
3	0.79	0.78
4	0.70	0.68
5	0.62	0.58
6	0.48	0.41
7	0.41	0.41
8	0.32	0.30
9	0.22	0.21
10	0.17	0.17
11	0.21	0.21
12	0.16	0.15
13	0.15	0.15
14	0.12	0.11
15	0.08	0.07
16	0.07	0.07
17	0.06	0.05
18	0.05	0.03
19	0.02	0.02
Average	0.12	0.12

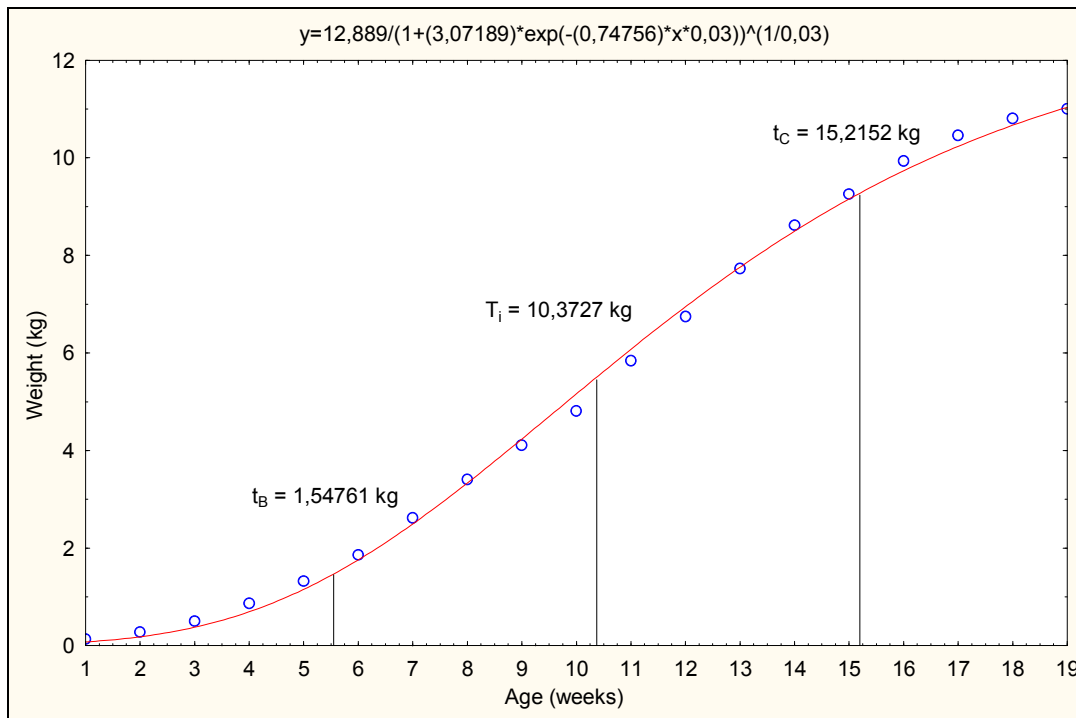
Average gain rates of heavy hybrid turkeys were 12.45% for toms and 12.11% for hens. Gain rates of both turkey toms and hens are less than gain rates of chickens reported by Kralik et al. (1996) and Ivanković (2002). Authors stated that in their researches growth rate of chickens in the 1st week was higher than 3.00 (in the 2nd week was around 1.5), while average growth rate at the end of fattening (42-49 day) was 0.90 (Ivanković, 2002).

Table 3. Characteristics of functions – growth model

Characteristics	Turkey toms	Turkey hens
A	17.966 kg	12.889 kg
T _I	10.6291; 7.21994	10.3727; 5.37551
t _B	5.4555; 1.8846	5.5302; 1.54761
t _C	15.8027; 12.7972	15.2152; 9.34517



Graph 1. Growth curve of turkey toms



Graph 2. Growth curve of turkey hens

Evaluation of the inflection point and specific growth phases of each turkey sex (as presented in Table 3 and Graphs 1 and 2) was completed by applying asymmetric S-function (Kralik and Scitovski, 1993). According to the parameters of asymmetric S-function, intensification of progressive growth phase in turkey toms started after the 5th week, and in hens it was prolonged for several days. Determined biological maximum of toms was 17.966 kg, and of hens 12.889 kg. Intensive growth of hens lasted up to the beginning of the 15th week, while toms grew intensively up to the end of that week. Positions of inflection point in hens were determined at the beginning of the 10th week, and in toms in the middle of the same week.

CONCLUSION

Based on the completed research into growth evaluation of the Nicholas 700 turkeys (30 toms and 30 hens) that lasted from the 1st to 133rd day, the following conclusions were drawn:

- End weight of turkey toms was 34.63% higher than of hens (14811±906 g : 11005±993 g). Differences in end weights between turkey sexes, as well as in weights over the whole fattening period were statistically very highly significant ($P < 0.001$).
- Average absolute and relative gains (gain rates) of toms and hens were 776 g, i.e. 12.45%, and 567 g, i.e. 12.11%, respectively.
- By the parameters of asymmetric S-function, intensification of progressive growth phase in turkey toms started after the 5th week, and in hens it occurred several days later.
- Determined biological maximum of toms was 17.966 kg, and of hens 12.889 kg. Intensive growth of hens lasted up to the beginning of the 15th week, while toms grew intensively up to the end of the 15th week.
- Positions of inflection point in hens were determined at the beginning of the 10th week, and in toms in the middle of the same week.

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