

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

---

Škrtić, Z.; Kralik, Gordana; Gajčević, Zlata

Source / Izvornik: **Poljoprivreda, 2007, 13, 141 - 144**

**Journal article, Published version**

**Rad u časopisu, Objavljena verzija rada (izdavačev PDF)**

Permanent link / Trajna poveznica: <https://um.nsk.hr/um:nbn:hr:151:194674>

Rights / Prava: [In copyright](#) / [Zaštićeno autorskim pravom.](#)

Download date / Datum preuzimanja: **2024-07-17**



Sveučilište Josipa Jurja  
Strossmayera u Osijeku

**Fakultet  
agrobiotehničkih  
znanosti Osijek**

Repository / Repozitorij:

[Repository of the Faculty of Agrobiotechnical  
Sciences Osijek - Repository of the Faculty of  
Agrobiotechnical Sciences Osijek](#)



## 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 5<sup>th</sup> 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 15<sup>th</sup> week, while toms grew intensively up to the end of the 15<sup>th</sup> week. Positions of the inflection point in hens were determined at the beginning of the 10<sup>th</sup> 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).

---

*PhD. Zoran Škrtić, Assistant Professor; Dr.Sc.Dr.h.c. Gordana Kralik, Full Professor; MSc. Zlata Gajčević - Faculty of Agriculture of Josip Juraj Strossmayer University of Osijek, Department of Special Zootechnics, Trg Sv. Trojstva 3, 31 000 Osijek, Croatia, e-mail: [szoran@pfos.hr](mailto:szoran@pfos.hr)*

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 20<sup>th</sup> 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. <sup>a</sup> significance | Weight gain of toms, g | Weight gain of hens, g | Stat. <sup>a</sup> significance |
|---------------------|-------------------|-------------------|---------------------------------|------------------------|------------------------|---------------------------------|
| 1 <sup>st</sup> 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. |

<sup>a</sup> 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 4<sup>th</sup>, 8<sup>th</sup>, 12<sup>th</sup> and 17<sup>th</sup> 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 17<sup>th</sup> week of fattening weighed 13.06 kg, and hens 9.57 kg, while the weights of toms at the end of the 18<sup>th</sup> 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 18<sup>th</sup> fattening week was 15.13 kg, while hens weighed on the average 6.93 kg at the end of 14<sup>th</sup> week.

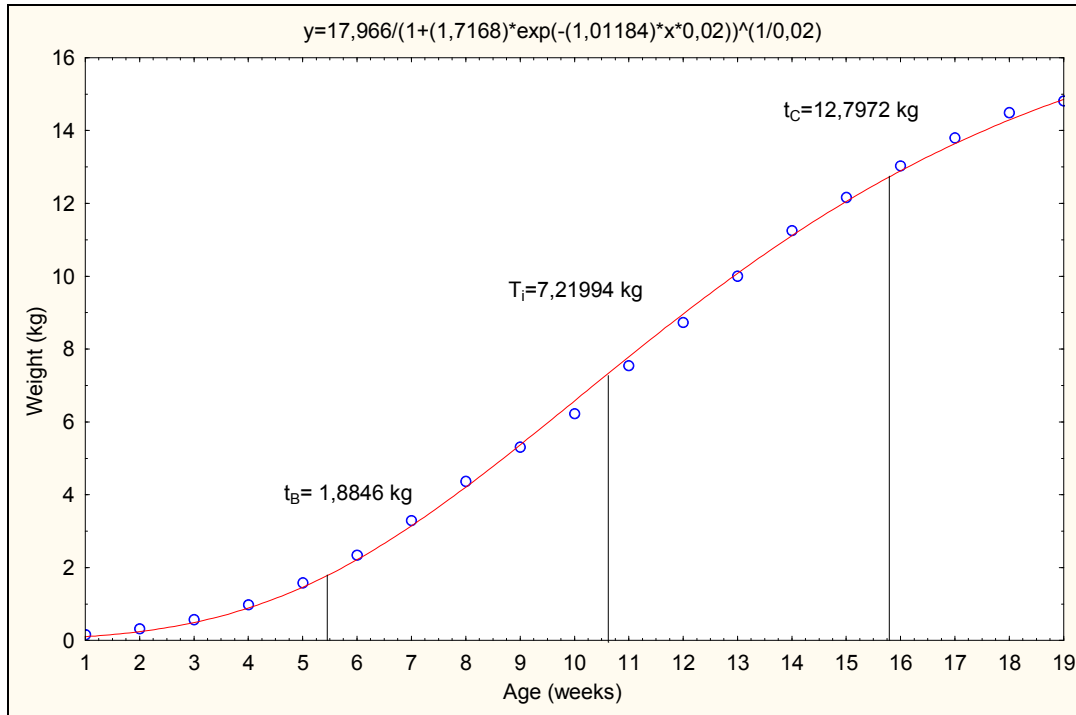
**Table 2. Growth rates of turkey toms and hens of Nicholas 700 provenience**

| 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                |

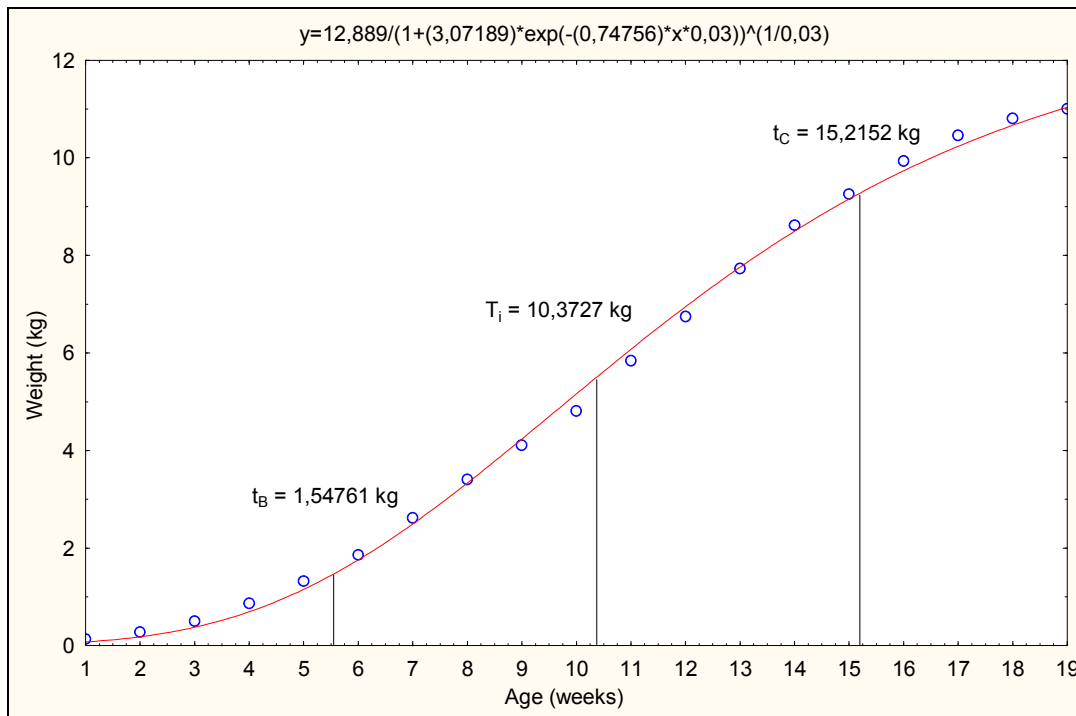
Average gain rates of heavy hybrid turkeys were 12.45% for toms and 12.11% for hens. Gain rates of both turkey toms and hens are less than gain rates of chickens reported by Kralik et al. (1996) and Ivanković (2002). Authors stated that in their researches growth rate of chickens in the 1<sup>st</sup> week was higher than 3.00 (in the 2<sup>nd</sup> 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 <sub>I</sub>  | 10.6291; 7.21994 | 10.3727; 5.37551 |
| t <sub>B</sub>  | 5.4555; 1.8846   | 5.5302; 1.54761  |
| t <sub>C</sub>  | 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 5<sup>th</sup> 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 15<sup>th</sup> 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 10<sup>th</sup> 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 1<sup>st</sup> to 133<sup>rd</sup> 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 5<sup>th</sup> 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 15<sup>th</sup> week, while toms grew intensively up to the end of the 15<sup>th</sup> week.
- Positions of inflection point in hens were determined at the beginning of the 10<sup>th</sup> week, and in toms in the middle of the same week.

## REFERENCES

1. Brenoe, U.T., Kolstad, K. (2000): Body composition and development measures repeatedly by computer tomography during growth in two types of turkeys. *Poult.Sci.* 79:546-552.
2. Ferket, P.R. (2003): Growth of toms improves substantially. *Watt Poultry USA*, July 2003, 38-44.
3. Hurwitz, S., Talpaz, H. (1997): Modelling of growth. 11<sup>th</sup> European Symposium on Poultry Nutrition. August, 24-28, 1997, Faaborg, Denmark, 148-157.
4. Ivanković, S. (2002): Modificiranje sadržaja masnih kiselina u mesu tovnih pilića. Doktorska disertacija. Agronomski fakultet Sveučilišta u Mostaru.
5. Jukić, D., Kralik, G., Scitovski, R. (2003): Least-squares fitting Gompertz curve. *Jornal of Computational and Applied Mathematics* 169:359-375.
6. Kidd, M.T., Kerr, B.J., England, J.A., Waldroup, P.W. (1997): Performance and carcass composition of large white toms as affected by dietary crude protein and threonine supplements. *Poult.Sci.* 76:1392-1397.
7. Kralik, G., Scitovski, R. (1993): Istraživanje značajki rasta brojlera pomoću asimetrične S-funkcije. *Stočarstvo*, 47(5-6):207-213.
8. Kralik G., Božičković, P., Škrtić, Z. (1996): Specifičnosti rasta i hranidba provenijencija tovnih pilića. *Krmiva*, 38(6):319-326.
9. Lehmann, D., Pack, M., Jeroch, H. (1996): Responses of growing and finishing turkey toms to dietary lysine. *Poultry Sci.* 75:711-718.
10. Noble, D.O., Muir, F.V., Krueger, K.K., Nestor, K.E. (1996): Effect of altering the early dietary protein levels on males from two strains of commercial turkeys. *Poult. Sci.* 75:1334-1344.
11. StatSoft, Inc. (2005). STATISTICA (data analysis software system), version 7.1. [www.statsoft.com](http://www.statsoft.com).
12. Von Bertalanffy, L. (1957): Quantitative laws in metabolism and growth. *Q Rev Biol. Sep*; 32(3): 217-31.
13. Talpaz, H., G.D. da Roza, Hearn, A.B. (1987). Parameter estimation and calibration of simulation models as a non-linear optimization problem. *Agricultural Systems* 23:107-116.

14. Tzeng, R, Becker, W.A. (1981): Growth patterns of body and abdominal fat weights in male broiler chickens. *Poult. Sci.* 60, 1101-1106.
15. Zeger, S.L., Harlow, S.D. (1987): Mathematical models from laws of growth to tools for biologic analysis: fifty years of "Growth". *Growth. Spring*, 51(1):1-21.

(Received on 28 May 2007; accepted on 19 July 2007)