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Conference paper

CARCASS QUALITY OF BROILERS RELATED TO GROWTH RATE IN FATTENING

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Summary

This research was carried out on 115 Ross female broilers. Data on live weights were collected from 91 broilers during 7 weeks of the fattening which was the base for modeling the growth curve using asymmetric S-function. The parameters of the model was: b=0.05164, c=30.87436. Stages of growth are determined by points t_B=2.18 weeks (298.36 g) and t_C=8.45 weeks (2736.69 g) with the point of inflection I=1478.85 g (5.32 weeks). By the model, 99.924% of variance was explained. This means that asymmetric S-function can be used as the model for description of broilers' growth. Other 24 broilers were slaughtered when they reached determined weights from 2200 till 3400 in the period from 7th till 12th week. The data obtained by dissection of those broilers on the main parts (breast, thighs with drumstick, wings and back) were used for the analysis of relative growth by allometric equation. Growth rates (b) for the most valuable parts and abdominal fat were: breast - 1.158; thighs with drumstick - 0.869; wings - 0.725; back - 1.063 and fat - 1.519. Allometric coefficients indicate that only fat production was intensive in studied period. This confirms the conclusion that the best age for the slaughter of the broilers is one established by asymmetric S-function.

Key words: broilers, growth, carcass quality, asymmetric S-function, allometric equation

Introduction

Growth is one of the main attributes of all living creatures. This process is so obvious that there is almost no need to introduce any particular formal definition. However, the dynamic changes occurring while animal grows are so

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complex that any attempt at understanding requires the introduction of some simplifications. When live weight of an animal is plotted as a function of age or time, very characteristic growth curve is formed. It is often called "sigmoid" or "S-curve" because of its shape. Growth related to time is sometimes referred as temporal growth. The phenomenon of growth as the basis of meat production constantly occupies the attention of researches. Equations describing the growth can be very helpfful providing the simplifications needed in understanding the whole process and allowing certain predictions to be made. Foundations in this area were made by Verhlust (1838), Brody (1945), von Bertalanffy (1957) and others who gave mathematical models of biological growth. Gomperz equation is now the most frequently used to describe the S-shaped growth of poultry (Rose, 1997) although others may be just as valid. Kralik and Scitovski, (1993) used asymmetric S-function for the analysis of Arbor Acres chicken growth. The process of forming the new structures and organs is called differentiation, whilst the remodeling of these structures and the changing proportion which they constitute of the whole body can be described as difterential growth (Lawrence and Fowler, 1997). On the other hand, the growth of various tissues and the changing composition is often expressed as relative growth as related to e.g. carcass or growth within a particular tissue (Walstra and De Greef, 1995). Huxley (1932) published the view that the proportions of the animal are determined by the overall weight. This theory became known as growth allometry and many authors are using it today in depicting the differential growth of various animals e.g. Katanbaf et al., (1988) in birds, Alamidurante (1990) in fish, Streitz et al., (1995) in sheep, Žgur et al., (1995) and Kastelic et al., (1996) in swine, Kwakkel et al., (1997) in chicken.

The first objective of this paper was to describe the growth of broilers by asymmetric S-function as generalized form of logistic function. Such model should give insight in growth characteristics by setting the stages of growth. It should also give a good base for accurate prediction of live weight of the broilers. Second objective was to apply allometric equation in order to examine the proportions and relative growth of the main parts of the broiler carcass in the latter phase of growth.

Material and methods

In this research 115 Ross female broilers were included. First 3 weeks broilers were fed starter which contained 21% proteins and 12.56 MJ/kg ME, From 22nd day till the end of the fattening broilers were given finisher with 20% crude protein and 12.52 MJ/kg ME. Live weight of the broilers was measured on the weekly basis till 7th week of life when 91 of them were slaughtered. This measures were the basis for modeling of the growth curve. Other 24 broilers were slaughtered when they reached determined weights from 2200 till 3400 g in the period from 7th till 12 week. Those broilers were further dissected on the main parts (breast, thighs with drumstick, wings and back) which were weighted separately. Data collected in this manner were used for the analysis of relative growth by allometric equation.

Asymmetric S-function with one inflection point was used for modeling of the growth:

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

Parameters b and c from this function were calculated on the basis of collected data. Letter A in this expression denotes the level of saturation, i.e. maximal live weight for certain genotype: 4000 g in this case. Symbol y is coefficient of asymmetry; value of 0.01 was chosen and this number fitted the best with the data. Inflection point till which progressive growth lasts and deggressive growth starts is determined by following expressions:

$$I = (\frac{i}{c\gamma} \ln \frac{b}{\gamma} \; ; \; \frac{A}{(1+\gamma)^{1/\gamma}})$$

Stages of growth were determined by t_B and t_C points calculated on the basis of terms:

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

Point B denotes maximum in the region of intensive growth (convex region) and point C is minimum value in the region of degressive growth (concave region). Interval ($t<t_B$) is stage of preparing growth; ($t_B<t<t_C$) is stage of intensive growth and ($t>t_C$) is stage of growth retardation.

Allometric function was used in growth description of the main parts of carcass (breast, thighs with drumsticks, wings, back and abdominal fat), each as a function of carcass weight:

$$\log Y = \log a + b * \log_e X \; ;$$

where Y is the weight of the carcass constituent, X is the weight of the carcass, log α is the intercept and b is the slope of the line, now called allometric coefficient. When b=1 it is said to be "unity" and indicates that the related part of the carcass develop proportionally. If $0<b<1$ the dependant variable is growing slower than the whole and it is considered as early maturing, while for $b>1$ the dependant variable is called late maturing, it grows faster than whole.

Results and discussion

Average weight, gain and weight predicted by asymmetric S-function of broilers during the fattening are given in table 1.

Table 1. - AVERAGE WEIGHT, GAIN PER WEEK AND PREDICTED AVERAGE WEIGHT OF BROILERS

Week	Weight	Gain	Predicted weight
1	113.984	113.984	96.728
2	262.600	148.616	256.516
3	513.060	250.460	528.220
4	884.975	371.915	900.823
5	1372.400	487.425	1335.595
6	1759.800	387.400	1785.290
7	2218.330	458.530	210.536

It is obvious that highest gain birds reached in 5th week. For researched group of broilers following model of growth is valid: b=0.05164, c=30.87436. Growth curve of the studied broilers is shown on Graph 1. The inflection point is I=1478.85 g reached after 5.32 weeks. Stages of growth are determined by points t_B=2.18 weeks (298.36 g) and t_C=8.45 weeks (2736.69 g). Correlation coefficient between theoretical and observed values was t=0.99962. In another words, 99.924% of variance was explained by the model. This research showed: that modeling of growth using asymmetric S-function is useful in studies of broilers' growth. Similar model was obtained by Kralik and Scitovski (1993). On the basis of the knowledge about the live weights of the broilers during first 3 weeks in fattening it is possible to predict future weights till 12th week.

Graph 1. - GROWTH CURVE, MATHEMATICAL MODEL AND PHASES OF GROWTH FOR TESTED BROILERS

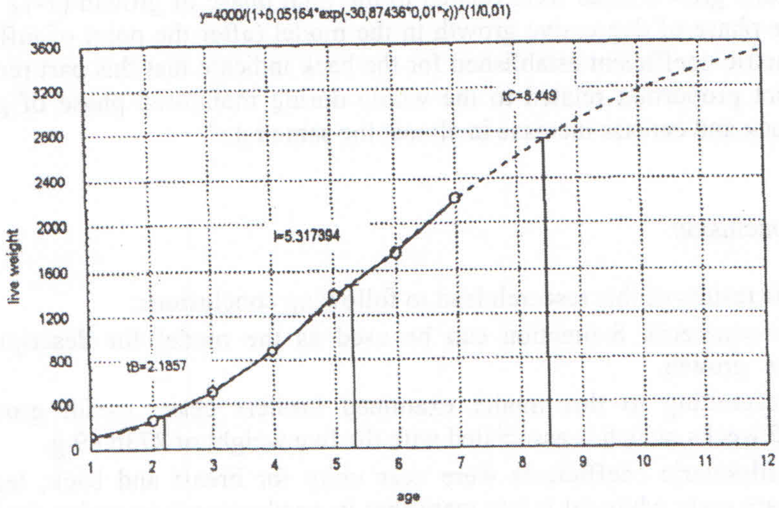

Table 2. - ALLOMETRIC COEFFICIENTS OF GROWTH FOR THE MAIN PARTS AND ABDOMINAL FAT OF BROILERS AND BELONGING STANDARD ERRORS

Part of carcass	Coefficient of allometry (b)	Standard error of b (SE_b)
Breast	1.158	0.115
Thigs with drumstick	0.869	0.119
Wings	0.725	0.098
Back	1.063	0.098
Abdominal fat	1.519	0.716

Relative growth rate expressed as allometric coefficients of different main parts of the carcass for Ross 208 broilers together with their standard errors are presented in table 2. It is obvious that the highest coeflicient of allometric growth had abdominal fat. This is in accordance with the reports of other authors (Kwwakkel et al., 1997; Rose, 1997). Breast muscle had allometric coefficient slightly higher than unity, which means that it grew a bit faster than the whole body, i.e. carcass weight in this case. Rose (1997) reported similar results. He also stated that different strains within a species may have different ratios. In this light should be viewed the fact that allometric growth coefficients (b) for legs (thighs with drumsticks) and wings in our study was less, than unity, while Rose (1997) noted higher values of b, i.e. faster growth of legs and wings than the whole. In addition, Rose (1997) indicated that allometric growth rates he reported were related to overall growth, while in this study growth rates were related to the final phase of growth (7-12 week), i.e. the phase of degressive growth in the model (after the point of inflexion). Allometric coefficient established for the back indicate that this part remain in constant proportion related to the whole during monitored phase of growth. The back and carcass increase in almost the same rate.'

Conclusion

The results of this research lead to following conclusions:

– asymmetric S-function can be used as the model for description of broilers' growth.

– according to this model examined broilers cease useful growth at t_C=8.45 weeks, which is associated with the live weight of 2736.69 g.

– allometric coefficients were near unity for breast and back; legs and wings are early while fat is late maturing; its production is intensive during the growth from 7th to 12th week.

– this results indicate that the best time for the slaughtering of examined broilers would be around 8.5 week (point t_B) because after this time follows stage of retardation; allometric coefficients confirmed this assessment.

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KAKVOĆA TRUPOVA BROJLERA U VEZI SA STOPOM RASTA U TOVU

Sažetak

Ovo je istraživanje provedeno na 115 ženki brojlera Ross. Podaci o živoj vagi sakupljeni su od 91 brojlera kroz 7 tjedana tova, što je bio temelj za oblikovanje krivulje rasta primjenom asimetrične S-funkcije. Parametri modela bili su b=0.05164, c=30.874. Stadiji rasta određeni su točkama t_B=2.18 tjedana (298.36 g) i t_C=8.45 tjedana (2736.69 g) s točkom infleksije T=1478.85 g (5.32 tjedna). Pomoću tog modela protumačena je varijanca 99.924%. To znači da se asimetrična S-funkcija može upotrijebiti kao model za opis rasta brojlera. Ostala su 24 brojlera zaklana, kada su postigli određene težine od 2200 do 3400 u razdoblju od 7. do 12. tjedna. Podaci dobiveni seciranjem glavnih dijelova (prsa, batak sa zabatkom, krila, leđa) upotrijebljeni su u analizi relativnog rasta ovih brojlera alometrijskom jednadžbom. Stope rasta (b) za najvrednije dijelove i trbušnu masnoću: prsa – 1.158, bataci I zabaci – 0.869, krila – 0.725, leđa – 1.063 i masnoća – 1.519. Alometrijski koeficijenti pokazuju da je samo proizvodnja masnoće bila intenzivna u razdoblju istraživanja. Ovo potvrđuje zaključak da je najbolja dob za klanje brojlera bila ona utvrđena asimetričnom S-funkcijom.

Ključne riječi: brojleri, rast, klaonička kakvoća, asimetrična S-funkcija, alometrijska jednadžba

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