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ANALYSIS OF PHENOTYPIC EXPRESSION AND GROWTH OF GILTS USING ASYMMETRIC S-FUNCTION

ANALIZA FENOTIPSKOG OČITOVANJA I RASTA NAZIMICA POMOĆU ASIMETRIČNE S-FUNKCIJE

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SUMMARY

Research on growth capacity of different genotypes of gilts was carried out at the station for performance test of gilts. Two groups of gilts, German Landrace and Swedish Landrace, 15 each were included in the experiment, while 3rd group contained 14 crossed gilts (Swedish Landrace x Large White). Using asymmetric S-function, differences were observed in growth characteristics between genotypes of gilts. Growth curves for gilts were depicted by following models:

German Landrace $$f_{(t)} = \frac{220}{(1+0{,}049 \cdot e^{-0.999 \cdot 0.010t})^{103}}$$

Swedish Landrace $$f_{(t)} = \frac{220}{(1+0{,}050 \cdot e^{-1.0 \cdot 0.010t})^{104}}$$

Crosses (SL x LW) $$f_{(t)} = \frac{220}{(1+0{,}051 \cdot e^{-1.0 \cdot 0.010t})^{102}}$$

Pigs with higher average daily gain reached maximal growth rates (inflexion point) in earlier age, and stage of progressive growth lasted a shorter time than in animals with lower average daily gain. Inflexion point was reached 166.59 days in German Landrace gilts, 171.14 days in Swedish Landrace and 168.53 days in crossed gilts (SL x LW).

Key words: gilt, genotype, growth curve, asymmetric S-function.

INTRODUCTION

In selection of gilts for reproduction, special attention is given to their growth. Since the basic issue in this matter is selection of individuals based on growth intensity during rearing of gilts, analysis of specific stages of growth and determination of point of infection, as well as average daily gain, can be of use as an additional indicator. The phenomenon of growth is of constant of constant interest for the researches and different models are

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used for its description. In the analysis of weight gain of an organism the basic assumption is that weight gain at certain time is proportional to the weight of the organism at the moment y(t) and biological potential [A-y(t)], where A stands for biological maximum of the weight of the examined species. These two factors have different intensity of their effect on weight gain in different time intervals. Different combinations of these two factors resulted in models of growth stated by von Bertalanffy (1957), Nedler (1961), Lewandowsky (1974), Ratkowsky and Reedy (1986), Ratkowsky (1988), Seber and Wild (1989) and Kralik and Scitovsky (1993).

Kralik at al. (1993) applied asymmetric S-function in the analysis and evaluation of boars' growth. They examined growth curves of boars in test from 30-100 kg. According to average daily gains achieved boars were divided into 3 groups. The analysis showed that boars, entering the test in a younger age, showed higher growth intensity that those beginning the test in older age (77.4, 83.4 and 82.6 days). In these boars the stage of progressive and degressive growth occurred earlier and lasted a shorter period of time. The asymmetric S-function could be therefore used for evaluation of the boars growth rate in older age based on the starting control measurements of animals.

In this study specifics of growth of German Landrace as well as of crossed gilts (Swedish Landrace x Large White) are examined with the aim of determining the influence of genotype on occurrence and duration of growth stages. By so called logistic function the growth of gilts will be described and characteristics of growth will be defined. On this basis, live weights of the gilts will be evaluated regarding the age of the genotypes mentioned. All apparent forms, cell structures and growth processes are connected to age.

MATERIALS AND METHODS

Research on growth capacity of different genotypes of gilts was carried out at the station for the performance test of gilts. Two groups of gilts, German Landrace and Swedish Landrace, 15 each were included in the experiment, while 3rd group contained 14 crossed gilts (Swedish Landrace x Large White). Female piglets for reproduction, adjusted to the environment of the testing station during 10 days, were selected for the research. In the selection of the piglets, care was taken that the criteria for selection of good reproductive were satisfied.

Gilts were fed diet ST-1 (16% crude proteins) from entering the test until 60 kg live weight and diet ST-2 from 60 to 100 kg (Table 1).

Table 1. Composition of the diets
Tablica 1. Sastav krmnih smjesa

Ingredient (%) - Sastojak (%)	Diet Krmna smjesa	
	ST-1	ST-2
Corn - Kukuruz	75.6	60.3
Soybean - Soja	9.0	-
Sunflower meal Suncokretova sačma	7.0	11.0
Fish meal - Riblje brašno	2.0	1.5
Meat + bone meal Mesno + koštano brašno	4.0	5.0
Phosphonal - Fosfonal	0.7	0.6
$CaCO_3$	0.7	0.6
Salt - Sol	0.5	0.5
Premix	0.5	0.5
Dry matter - Suha tvar	87.77	87.62
Crude protein - Sirove bjelančevine	16.01	14.03
Crude fat - Sirova mast	4.14	4.43
Crude fibers - Sirova vlaknina	3.75	3.93
Crude ash - Sirovi pepeo	5.00	5.11
Ca	0.84	0.88
P	0.44	0.45
Zn (mg)	80.00	80.00
Cu (mg)	20.00	20.00
Lysine – Lizin	0.70	0.52
Methionine + cystine Metionin + cistin	0.59	0.54
Triptophan - Triptofan	0.18	0.14
Feeding units - Hranidbene jedinice	1.22	1. 22
ME (MJ/kg)	13.07	13.00

Animals were weighed at the beginning of the research and every 21 day during the test. Growth of the gilts was described by asymmetric S-function (Kralik and Scitovski, 1993):

$$f(t) = \frac{A}{(1+be^{-c\gamma t})^{1/\gamma}}, \qquad A,\ \gamma > 0$$

Asymmetric S-function with one point of inflexion is strictly increasing in the whole range of definition. Parameters b and c are determined on the basis of experimental data by least squares method, while biological maximum and coefficient of asymmetry were chosen on the basic of experience. When values of optimal parameters of generalized logistic function are known, it is possible to evaluate the stages of growth. For t<tI the function is concave – the growth is degressive. Hence, it is of top interest to find the point of maximum tB in the interval of progressive growth (t<tI), and the point of minimum tC in the interval of degressive growth (t>tI)

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

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

Interval t ≤ tB is the stage of preparing growth, interval tB ≤ t ≤ tC is the stage of intensive growth, and interval t ≤ tC the stage of growth retardation.

RESULTS AND DISCUSSION

The control of the live weights of gilts at certain periods during the test showed that there were significant differences between genotypes (Table 2) due to different intensity of weight gain in rearing (Table 3).

For reaching the final weight of 102-103 kg, in equal conditions of rearing and feeding regimes, German Landrace gilts needed 90.3 days, Swedish Landrace 94.66 days and crossed gilts (SL x LW) 93.94 days (P>0.05).

Table 2. Average values and variability of live weights (kg) of gilts
Tablica 2. Srednje vrijednosti i promjenljivost živih masa (kg) nazimica

Time of measurement In test Vrijeme mjerenja u testu	Genotypes of gilts - Genotipovi nazimica					
	GL – NJL		SL – ŠL		SL x LW - ŠL x VJ	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Start of test - Početak testa	32.63	2.02	32.17	1.87	31.18	1.10
21st day - 21. dan	47.33	1.87	45.77	2.78	45.53	2.48
42nd day - 42. dan	62.77	4.45	58.43	3.39	61.36	2.84
63rd day - 63. dan	80.60	4.31	76.53	4.14	78.07	3.12
84th day - 84. dan	98.77	4.44	94.13	5.15	96.14	4.20
End of test - Kraj testa	103.17	2.74	102.13	2.26	102.79	2.12

In the first control period German Landrace gilts had the highest average daily gain of 700 g/day. In the second control period crossed gilts gained on average 753.81 g/day, which was the highest gain in that period, while in the third control period Swedish landrace gilts had the highest gain of 861.90 g/day. Statistically significant differences in average daily gains were established between German Landrace and Swedish Landrace gilts, as well as between Swedish Landrace and crossed gilts (P<0.05) in the second control period. German Landrace gilts (865.24 g/day) had the highest gain in the fourth control period and in the fifth gilts of Swedish Landrace (749.80 g/day).

It is obvious from the presented data that average daily gains tended to increase from the first to the fourth control period, while average daily gains in the last period were a bit lower. The highest average daily gain (775.76 g/day) was determined for German Landrace gilts. Crossed (LW x SL) and Swedish Landrace gilts had average daily gains of 762.38 and 738.99 g/day, respectively ($P<0.05$).

Table 3. Average values and variability of average daily gain (g) of gilts in control periods
Tablica 3. Srednja vrijednost (g) i varijabilnost prosječnog dnevnog prirasta nazimica prema kontrolnim razdobljima

Control period in test Kontrolno razdoblje u testu	Genotypes of gilts - Genotipovi nazimica					
	GL – NjL		SL – ŠL		SL x LW - SL x VJ	
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
First - Prvo	700.00	58.87	647.62	122.80	683.33	125.44
Second - Drugo	735.24	180.85	602.86	131.85	753.81	99.10
Third - Treće	849.05	85.21	861.90	117.06	795.71	54.23
Fourth - Četvrto	865.24	110.10	838.09	114.96	860.48	99.65
Fifth - Peto	634.59	135.88	749.80	148.25	669.06	137.47
Average - Prosjek	775.76	51.58	738.99	61.74	762.38	58.63

Gajić, 1989. compared productive characteristics of Swedish Landrace and F1 generation of crosses between Swedish Landrace and Large White in the performance test of gilts. Using multiple regression analysis he established significant differences in average values between groups of gilts and their correlation. The strongest correlation was established between age at the end of test and average daily gain. Kralik et al., 1990., while comparing fattening and slaughtering characteristics of Large White, Swedish Landrace and their crosses, found the highest gain and lean meat percentage in Large White. Gajić and Fidler, 1990. determined a significant influence of genotype in direct test of Swedish Landrace and crossed (SL x LW) gilts. Values were higher in the group of crossed gilts, but variability was also high.

Parameters of the function - growth model, points of inflection (tI) and points which denote stages of growth (tB, tC) are presented in Tables 4 and 5. Regarding the fact that all the gilts were reared in the same conditions and at the same feeding level, differences between analyzed indicators can be explained by the influence of genetic potential. In the interval $t \leq tI$ growth of the gilts is progressive, in the interval $t \geq tI$ growth is degressive; after this follows the period of retardation of growth $t \geq tC$.

Table 4. Parameters of the function - growth model for gilts, regarding the genotype
Tablica 4. Parametri funkcija - modela rasta nazimica s obzirom na genotip

Genotype of gilts Genotip nazimica	Parameters of the function Parametri funkcija		
	b	c	γ
German landrace Njemački landras	0.0496494	0.99998	0.0097627
Swedish landrace Švedski landras	0.0502122	1.00001	0.0096420
Crosses (SL x LW) Križanke (ŠL x VJ)	0.0512695	1.00006	0.0098113

Table 5. Points of inflexion and stages of growth according to the genotype of gilts
Tablica 5. Točke infleksije i razdoblja rasta prema genotipu nazimica

Genotype – Genotip	t_B	y_B	t_I	y_I	t_C	y_C
German landrace - Njemački landras	67.57	16.40	166.60	81.33	265.63	150.51
Swedish landrace - Švedski landras	70.88	16.39	171.14	81.32	271.40	150.50
Crosses (SL x LW) - Križanke (ŠL x VJ)	69.99	16.40	168.53	81.33	267.06	150.51

Analysis of the data shows that the duration of intensive growth stage of German Landrace gilts was from 67.57 until 265.63 days. Duration of this stage in Swedish Landrace gilts was 70.88 - 271.40 days and in crossed gilts (SL x LW) 69.99 - 267.06 days. Data show that German Landrace gilts are characterized by higher intensity of growth i.e. that they are an earlier maturing productive type in relation to other two genotypes. This is also confirmed by the fact that to reach live weight of 150 kg German Landrace gilts needed 265.63 days, crosses (SL x LW) 267.06 days and Swedish Landrace gilts needed 271.40 days.

Growth curves for gilts were depicted by the following models:

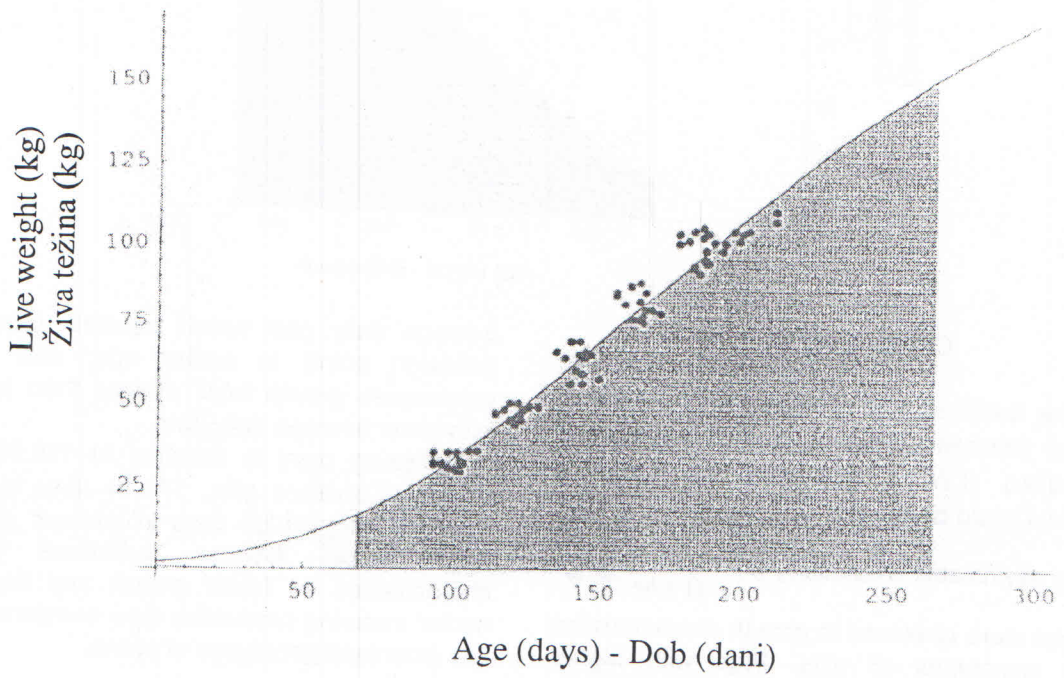
German Landrace $$f_{(t)} = \frac{220}{(1+0{,}049 \cdot e^{-0.999 \cdot 0.010t})^{103}}$$

Swedish Landrace $$f_{(t)} = \frac{220}{(1+0{,}050 \cdot e^{-1.0 \cdot 0.010t})^{104}}$$

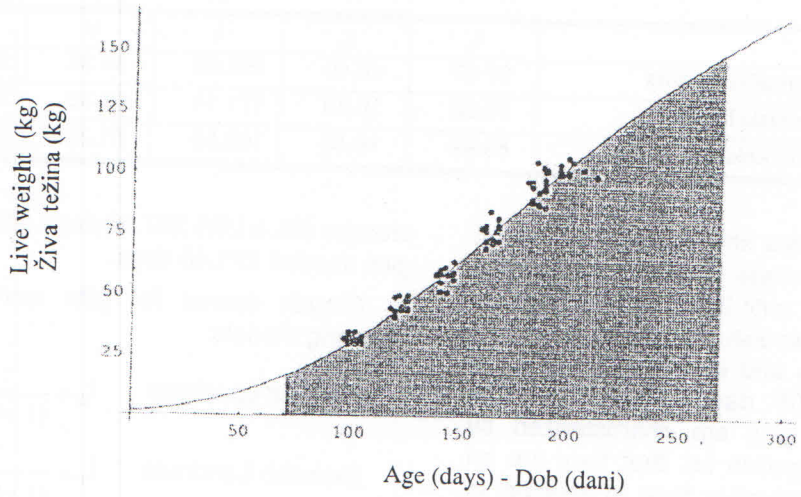
Crosses (SL x LW) $$f_{(t)} = \frac{220}{(1+0{,}051 \cdot e^{-1.0 \cdot 0.010t})^{102}}$$

Graphs 1-3 show asymmetric S-functions for analyzed genotypes of gilts.

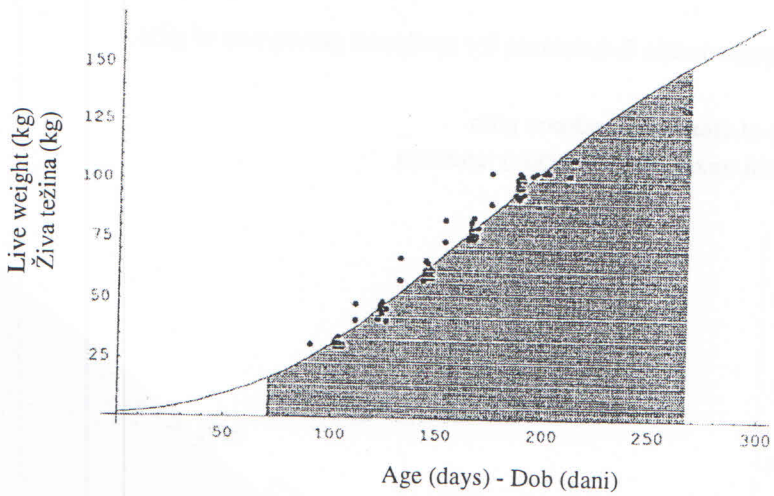
Graph 1. Growth curve of German Landrace gilts
Grafikon 1. Krivulja rasta nazimica njemačkog landrasa



Graph 2. Growth curve of Swedish landrace gilts
Grafikon 2. Krivulja rasta nazimica švedskog landrasa



Graph 3. Growth curve of crossed gilts (SL x LW)
Grafikon 3. Krivulja rasta križanih nazimica (SL x VJ)



CONCLUSION

On the basis of this research on capacity of growth of German Landrace, Swedish Landrace and crossed (LW x SL) gilts the following conclusions could be drawn:

Using asymmetric S-function $f(t) = \frac{A}{(1+be^{-ct})^{1/\gamma}}$ differences were observed in growth characteristics between genotypes of gilts. Pigs with higher average daily gain reach maximal growth rates (inflexion point) in earlier age, and stage of progressive growth lasts shorter than in animals with lower average daily gain.

Inflexion point is reached in 166.59 days in German Landrace gilts, 171.14 days in Swedish landrace and 168.53 days in crossed gilts (LW x SL). Hence, German Landrace gilts are characterized by faster growth and they are an earlier maturing production type compared to other two examined genotypes of swine.

The described model enables right time selection of gilts regarding the growth capacity of each individual.

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SAŽETAK

Istraživanje kapaciteta rasta različitih genotipova nazimica obavljeno je u stanici za performans test nazimica. U istraživanju su bile dvije skupine po 15 nazimica pasmina njemački landras i švedski landras, a treću skupinu činilo je 14 križanih nazimica švedskog landrasa i velikog jorkšira. Uporabom asimetrične S-funkcije utvrđene su razlike u specifičnostima rasta između pojedinih genotipova nazimica. Krivulje rasta nazimica opisane su pomoću sljedećih matematičkih izraza za:

njemački landras $$f(t) = \frac{220}{(1 + 0{,}049 \cdot e^{-0.999 \cdot 0.010t})^{103}}$$

švedski landras $$f(t) = \frac{220}{(1 + 0{,}050 \cdot e^{-1.0 \cdot 0.010t})^{104}}$$

križanke (ŠL x VJ) $$f(t) = \frac{220}{(1 + 0{,}051 \cdot e^{-1.0 \cdot 0.010t})^{102}}$$

Svinje s većim prosječnim dnevnim prirastom postižu maksimalne brzine prirasta (točka infleksije) u ranijoj dobi, a razdoblje progresivnog rasta traje kraće vrijeme nego kod životinja s manjim prosječnim dnevnim prirastom. Točka infleksije nastupila je kod nazimica njemačkog landrasa pri dobi od 166,59 dana, švedskog landrasa 171,14 dana, a križanki (ŠL x VJ) pri dobi od 168,53 dana.

Ključne riječi: nazimica, genotip, krivulja rasta, asimetrična S-funkcija